

The Blast Furnace *and* Steel Plant

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Discovery

THE opening of the tomb of Tut-ankh-Amen bears deep significance to the world to-day. In the disordered state existing in Europe and Asia Minor, it is a welcome relief to note that present day civilization finds time to enthuse over this strange vista fortuitously preserved from that far distant civilization. The present era is a period of Discovery, if nothing else, and the lure of the adventurous is just as vivid to-day as when the Crusaders set forth in blindest zeal.

Important Discoveries have unsuspected values and influences, and Tut-ankh-Amen most of all.

Many marvelous things were found in this room, apparently the Portal to a King's Heaven, sealed more than 3,000 years ago, but perhaps the most remarkable is the discovery that the minds of men were not greatly different then than now. They had the same ambitions, the same vanities that we boast today; they desired to express themselves, they desired to propitiate their deity, they hated and feared and fought.

Many material things found proved that they possessed a definite knowledge of metals, and metal working, iron, bronze and gold; but more interesting, the uses and proportions of these three metals seem to indicate that their evaluation of them was in nearly the same ratio as ours. Here is a direct negation of a fundamental conception by Marx & Engle that "Values depend directly upon the amount of human labor wrapped up in them," for in their crude manipulations, iron must have required more labor in its fashioning than gold. Why was gold more highly valued?

Many important things were NOT found. What was the "labor policy" which permitted the building of the Pyramids? What constituted success in the individual sense? What form of financial structure was employed to maintain the state? What was the machinery of taxation? Did they then have "reform" parties, persistently dissatisfied with everything? Or were these matters left to small consideration by a people content to enjoy the good things of life in their normal proportions?

Many imaginations have been stirred by the results of Lord Roncoman's 33 years of patient research, and many hypotheses will be drawn for and against. But it is always so with any Discovery; each is a seven days' wonder until the novelty wears away; it may be a tomb, as today, or a city tomorrow as Mesopotamia suggests; it may be a North or South pole or a continent, by a Peary or a Scott or a Magellan; it may be proof of the Divinity of a God, or a question as to that Divinity; it may be a new basic element as Hafnium by Coster & Hevesy of Copenhagen; or the application of a fundamental principle to a new use, as Steinmetz's one million volt lightning set; all are marvelous results of concentration to a given purpose.

Our total civilization may be accepted as an ascending series of important Discoveries, each relative, but all spectacular to our limited intelligence. The last Eureka merely Seems the greatest.

Speed Control of Polyphase Motors

An Exhaustive and Complete Analysis of the Factors Involved in the Operation of This Type Motor—Classification of Various Systems of Control and a Description of Each System.

By GORDON FOX*

THE rate of rotation of an induction motor is determined by its synchronous speed and the rotor slip. In order to cause a change in speed, at least one of these factors must be varied. Several methods of speed control are applied to the polyphase induction motor. Three methods function through change of synchronous speed. These are:

- Variable frequency system.
- Multispeed motor.
- Cascade set.

Three common control methods depend upon variation of the amount of slip. These are:

- Secondary resistance or "rheostatic" control.
- Primary voltage control.
- Dynamic control.
 - Kramer system.
 - Scherbius system.
 - Frequency converter system.

Combinations of these methods are also used. The various systems have widely differing characteristics. Each finds application for particular classes of work. None of the methods is suited for universal usage.

Variable Frequency System.

The synchronous speed of an induction motor depends upon the circuit frequency and the number of poles per phase in the primary winding. The great majority of induction motors operate on systems having a fixed frequency. The use of variable frequency or multiple frequencies involves special provision in the way of generators or frequency changers, complications which are not ordinarily justified. There are a few occasions, however, when such systems can be employed to advantage. It is therefore of interest to note briefly the qualifications of this method of speed control.

If a motor be provided with a frequency below normal, it will operate at a correspondingly reduced speed. The voltage impressed must be reduced in the same proportion that the frequency is reduced. This is because the counter voltage is proportional to the frequency, or rate of change of flux, and is thus also proportional to the speed. The effects of change of frequency and proportionate change of voltage practically offset each other in most respects so that the motor characteristics remain essentially unchanged, except in the matter of speed. The motor retains a constant torque capacity both as to normal and maximum values. The hp. output is approximately a constant current rating. The reduction in frequency is accompanied by diminishing core losses, tending to reduce heating. This tendency is about offset by the fact that

reduction in speed lessens the ventilation so that the losses must be lower if the same operating temperature is to be maintained.

Where a wide speed range is involved a limiting condition exists in that the primary resistance drop remains practically fixed while the impedance decreases with decreasing frequency. At very low speeds the resistance drop becomes relatively high and causes a diminution of pull out torque.

Fig. 1 shows the speed torque curves of a 35 hp. squirrel cage motor of special design, operated over a

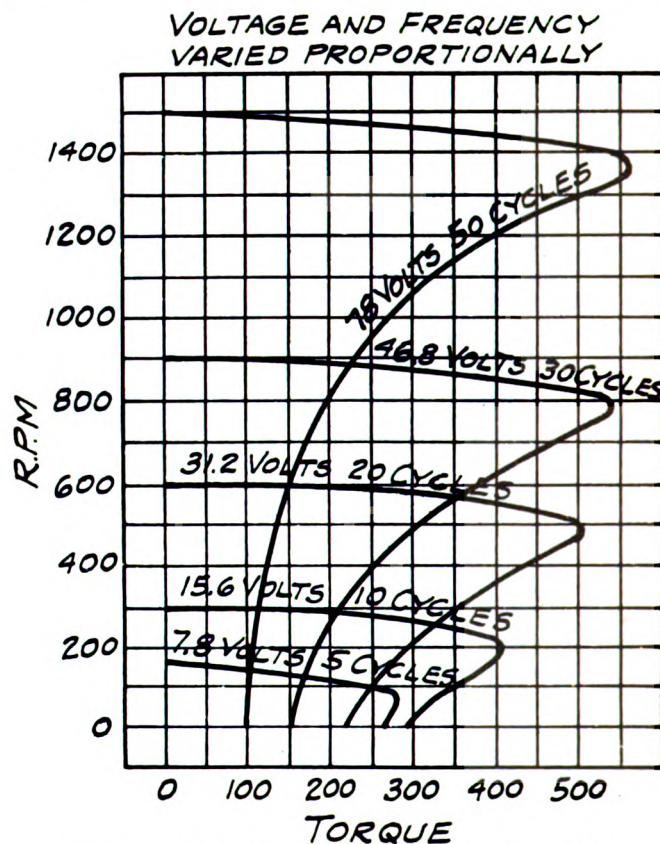


FIG. 1—Dgm. speed torque curves of 35-hp. motor on various frequencies.

range of frequencies. It is to be noted that the pull out torque falls off at decreased frequencies, particularly at very low speeds.

Another consideration of interest is shown in these curves. It may be noted that, at 50 cycles, the speed torque curve is flat and the starting torque is low, the earmarks of a low resistance squirrel cage winding. At lower frequencies the speed curve is less flat and the starting torque is higher, both relatively and actually. This is due to the fact that, as low frequencies, the

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secondary resistance, a constant quantity, achieves relatively greater influence and gives the motor the characteristics of a motor with high resistance rotor. Incidentally it is evident that a squirrel cage motor can be started to quite good advantage if connected to a generator whose speed and voltage are gradually increased.

The Multi-Speed Motor.

If an induction motor be operated on a circuit of a fixed frequency, its synchronous speed can be changed only by changing the number of poles in the primary winding. This can be accomplished by using two or more separate primary windings, each having a different number of poles, or by using a single winding which can be connected so as to form different numbers of poles. Theoretically a number of speeds are possible. Practically, four synchronous speeds are the maximum number feasible for squirrel cage motors and two for wound rotor motors. The squirrel cage rotor is adapted to any number of poles whereas the secondary windings of the wound rotor must be reconnected for different speeds.

Two synchronous speeds, bearing the ratio 2 to 1, may be secured by simple reconnection of one set of stator windings. A special winding is used with coils having a throw which is short pitch for the small number of poles and over pitch for the large number of poles. The high speed is obtained with the winding connected in a normal manner as shown in Fig. 2. Low speed is obtained by rearranging the circuits so that all coils of each phase have like polarity as indicated in

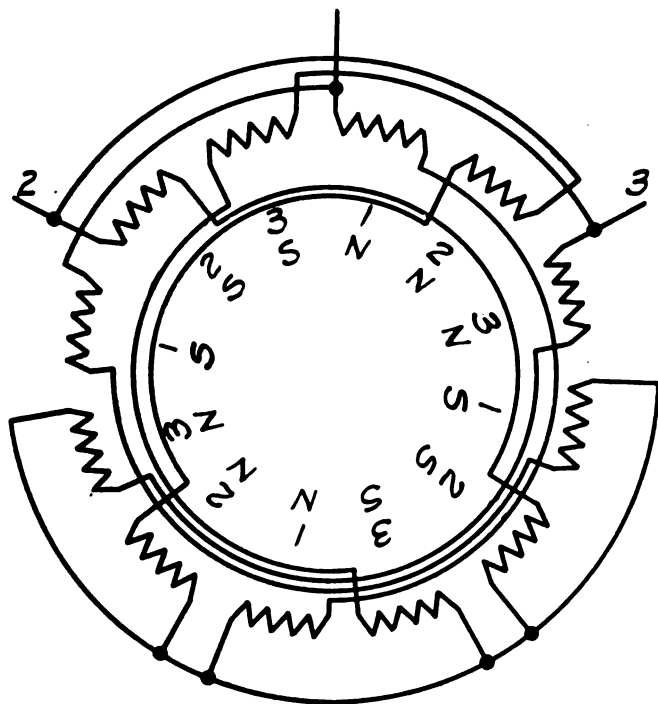


FIG. 2—Dgm. multispeed motor stator winding connected four poles per phase, double star for high speed—elec. rev.—1917.

Fig. 3. An equivalent number of consequent poles of opposite polarity then occur at intermediate points. The net result is twice the number of poles of half the arc. The speed of rotation of the field is then halved, reducing the synchronous speed accordingly. It will be noted that, in reconnecting, the coils have been changed from parallel to series. When the rotation of the revolving field is halved, the rate of change of flux

is proportionately decreased so that twice the turns are required in series, for the low speed, to produce the proper countervoltage. The changes in the connections are made by bringing out the coil ends and completing the connections for either arrangement in the controller.

Speed ratios other than 2 to 1 must be obtained through the use of separate stator windings. Thus,

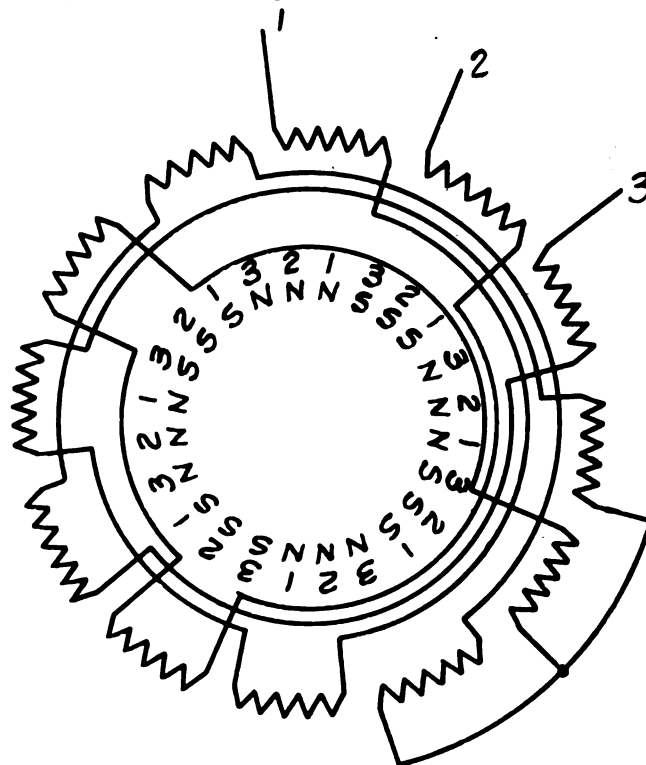


FIG. 3—Dgm. multispeed motor stator winding connected single star for eight poles, giving half speed.

a 60 cycle motor having a six pole winding and a four pole winding, will operate at either 1200 rpm. or 1800 rpm. If these two windings are arranged for reconnection for consequent poles, two additional speeds, 600 rpm and 900 rpm respectively, are possible. Where separate windings are employed, one set is placed in the bottom of deep stator slots, the second winding being inserted above them, there being thus two layers. Access to the lower coils for repairs can be gained only by removal of portions of the top layer.

The controller of a squirrel cage motor having a two to one ratio is not complicated. But six leads are brought out from a three phase motor of this type. Two speeds from two separate windings, also requires six leads between motor and controller. Four speeds from two windings requires 12 leads between motor and controller. Wound rotor motors demand twice as many leads since their rotor windings ordinarily must be reconnected. This introduces complexity, requires more slip rings and brushes and makes the controller very expensive. Wound rotor motors are not regularly built for more than two synchronous speeds.

Multi-speed motors are ordinarily built for three phase circuits only. For use on two phase circuits, Scott connected transformers are used to change to three phase. Controllers for two phase motors would be more complicated and more expensive. It should be noted that changes from one speed to another are obtainable only by opening the primary circuit and then closing it with different connections. This necessary

interruption of the power supply is an undesirable feature of the multi-speed motor.

The multi-speed motor is not in reality an adjustable speed machine since a limited number of speeds can be obtained. In the great majority of applications but two speeds are possible. At each setting the motor operates essentially as a simple induction motor,

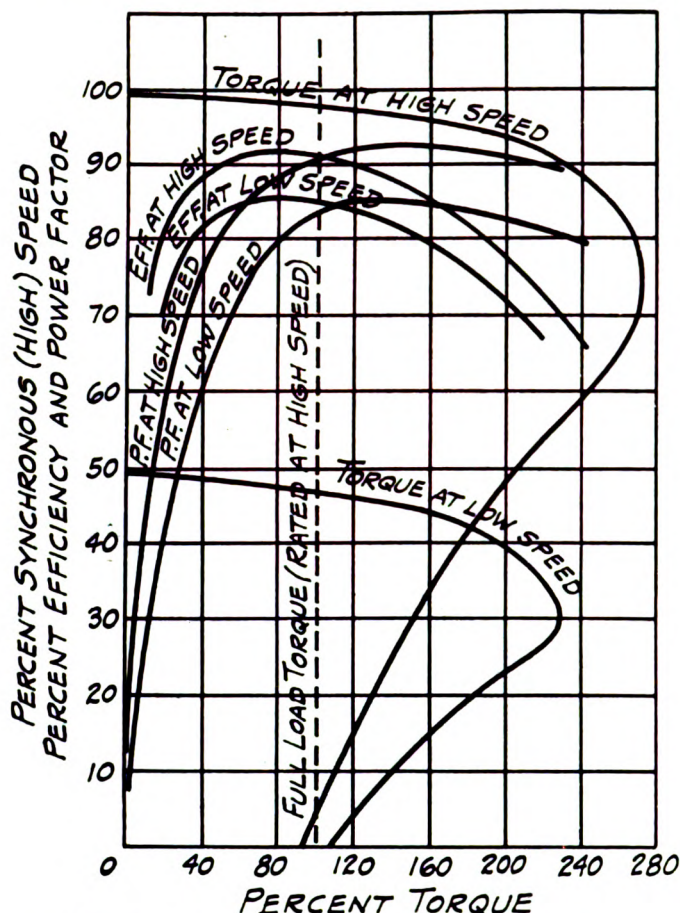


FIG. 4—Dgm. characteristics of a multispeed induction motor having 2 to 1 speed ratio.

having squirrel cage constant speed or wound rotor varying speed characteristics, according to type. Since most multi-speed motors are of the squirrel cage design they offer two, three or four widely differing but approximately constant speeds. The torque remains approximately the same for each connection and the horse power capacity is greater at the higher speeds. A multispeed motor is essentially a constant torque machine.

The efficiency of multi-speed motors is quite high, being but slightly inferior to that of the simple induction motor. The efficiency is usually a little better at the faster speed. The power factor of the multi-speed motor is likely to be rather low, particularly at the lower speeds. The deep slots required to carry the two layer windings contribute to this fault. The starting torque per ampere varies approximately inversely as the speed, depending upon the connection used at starting. Squirrel cage multispeed motors require a compensator for starting. Change from one speed to another can usually be accomplished by movement of the drum controller which reconnects the windings. This change is accomplished by a sudden rush of current similar to that at starting. Fig. 4 shows the char-

acteristics of a two to one, squirrel cage multi-speed motor.

Multi-speed motors find a limited field of application. Where two or three fixed speeds will suffice and constant torque is required, they are well adapted and inexpensive. The great majority of these motors have squirrel cage rotors. Multi-speed motors with phase wound rotors have been used to a limited extent for main roll drives in steel mills and elsewhere. The multispeed motor has been recently adopted for elevator service and similar duty, the fast speed being the normal running condition, the slow speed being used as a slow down in approaching a stop.

Cascade Sets.

By means of cascade connection, two induction motors that are rigidly connected, usually upon the same shaft, may afford a number of synchronous speeds. A combination of two such motors is called a cascade set. One of the motors must have a wound rotor. The two motors are usually arranged for different numbers of poles. By operating either motor alone, two synchronous speeds are obtainable. If the motors are built for multi-speed connections of the stator windings four synchronous speeds are possible through use of the motors individually. If the secondary of the wound rotor motor be connected to the primary of the second motor as in Fig. 7, the second motor is subjected to a voltage at variable frequency. The set will operate at a point dependent upon the combined number of poles of the two motors. This may be seen most readily by considering a cascade set composed of two motors, both having the same number of poles. When the first motor is at rest, its rotor winding has generated within it a voltage at line frequency and this is applied to the stator of the second motor. Both motors then tend to accelerate. As the speed increases the frequency of the current in the circuit composed of the rotor of the first motor and the stator of the second motor, is decreased. At half speed the frequency of the current in this circuit is half line frequency. At this frequency the second motor will run at half speed. If the rotor of the first motor should increase its speed further the frequency applied to the stator of the second motor would decrease and the second motor would tend to slow down. It is thus evident that the normal speed of the set is half that of either motor operating alone. In general the speed of a cascade set equals:

$$\frac{\text{cycles} \times 120}{P_1 \pm P_2}$$

Where P_1 and P_2 are the number of poles of the first and second motors, respectively. The plus sign is used in the case of direct cascade connection and the minus sign in the case of differential cascade connection. Motors are connected in direct cascade if they both tend to start in the same direction and in differential cascade if they tend to start in opposite directions. It should be evident that direct cascade reduces the speed of a set below that of the synchronous speed of the first motor while differential cascade increases the operating speed above the synchronous speed of the first motor. If a set is arranged for both direct and differential cascade connection the speed range may be materially increased. The change from one type to the other is accomplished by reversal of one phase in the secondary circuit of the first motor.

The differential cascade connection is limited in its application. A differential cascade set exerts com-

paratively low starting torque since the motors are opposing each other. It is necessary to bring the set up to speed by use of the second motor alone. Differential operation may then be secured by reducing from the higher speed, using the cascade connection. It is necessary that the second motor have less poles than the first motor in order that this higher speed may be possible. A differential cascade set will not accelerate from a low speed.

It will be seen that cascade sets are similar to multi-speed motors in that they afford a number of fixed synchronous speeds. If the second motor of the set is of the wound rotor type it is possible to utilize rheostatic control to obtain intermediate speeds. The number of synchronous speeds available from direct cascade sets together with the number of terminals to be brought out to controllers is given in the following table:

First Motor	Second Motor	Number of Syn. Speeds	Number of Leads
Wound rotor	Squirrel cage	3	9
Wound rotor	Wound rotor	3	12
Wound rotor	Squirrel cage Multi-speed	5	12

The capacity of a cascade set depends upon the relative sizes of the units and the method of operation and much depends upon the behavior of the load at different speeds. The torque of each motor of the set is approximately equal to the total torque $\times$ the ratio

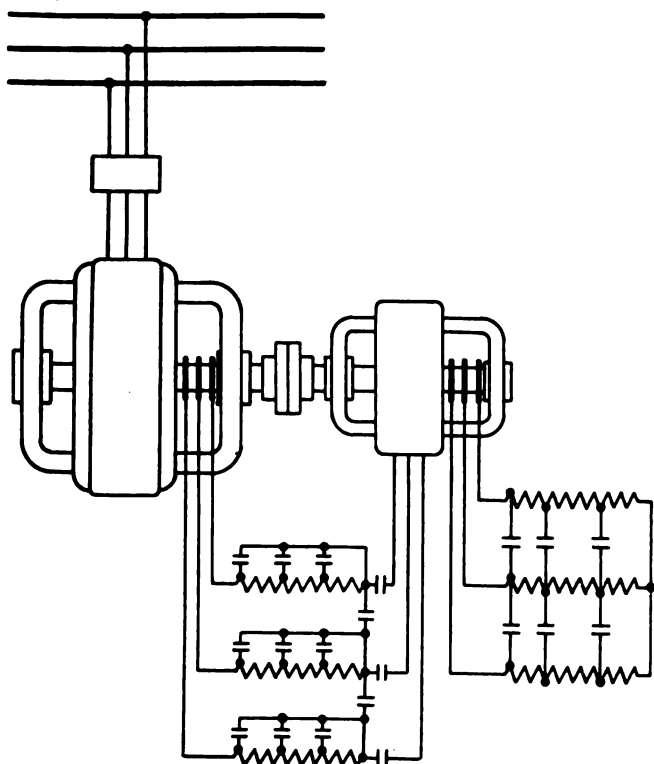


FIG. 5—Dgm. connections of two motors in cascade.

of the number of poles of that motor to the number of poles of the two motors combined. Thus, in a set having one unit with four poles and one unit with eight poles, the four pole motor will exert one-third of the combined torque. Since the power of the four pole motor must pass through the eight pole motor, it does not increase the maximum torque of the set. As the set operates in cascade at reduced speed the capacity is proportionately reduced. The break down

output of the set will be a little less than two thirds of that of the large motor running alone. The lowering of the breakdown capacity through cascade operation forces the use of comparatively large units. With two units having equal numbers of poles the breakdown capacity of the set in cascade is less than half that of a single unit. If one machine has sixteen poles and the other four poles the breakdown capacity is nearly four-fifths of that of the larger sixteen-pole motor. Loss of overload capacity is thus less severe where moderate speed changes are secured by addition of a small motor having few poles in cascade with a larger motor with a comparatively large number of poles. With differential cascade connection the torque of the second motor opposes that of the first motor and thus reduces the torque of the set with increase of speed. The proper application of a cascade set thus requires accurate knowledge of load conditions.

A number of speed changes may be accomplished with cascade sets without opening the primary circuit. This is done by introducing resistance and cutting it out in steps. Fig. 5 shows the location of the resistance used for this purpose. The ability to change speed without primary switching is desirable.

The efficiencies of the individual units of a cascade set are the same as those of ordinary induction motors of the same type. The efficiency of the combined set is somewhat less than that of a multi-speed motor of similar capacity. The efficiency is necessarily low since the input of the second unit must pass through the first unit. The power factor of a cascade set is rather poor. The magnetizing current for the set is that of the combined units and the magnetic leakages are also additive. Large magnetic leakage causes not only poor power factor but also low maximum torque. Fig. 6 shows the characteristics of a cascade set made up of two like units operating in cascade.

Cascade sets are not commonly employed in small sizes but large units are sometimes used where special speed ratio other than two to one are desired. They may also be used where high primary voltage would prohibit the switching operations incident to the use of the multi-speed motor. It is desirable that the horse power required at high speed be greater than that at low speed since the capacity of the set is decreased at low speeds. Cascade sets are comparatively less expensive, more economical and more efficient where only moderate changes are obtained through the use of a comparatively small second motor.

Secondary Resistance or Rheostatic Control.

It has been already pointed out that the actual speed of an induction motor is somewhat below synchronous speed. The amount of difference between synchronous speed and actual speed depends upon the slip. The slip depends upon the load and the resistance of the rotor circuit. Evidently, with a given load, it is possible to secure a moderate change in speed through variation of the slip by changing the resistance of the secondary circuit. This method is applicable by means of wound rotor motors supplied with controllers and external secondary resistance.

This is a rather commonly used method but is limited in desirable features. Only a moderate range of speeds is possible. Synchronous speed is the maximum rate obtainable and about half synchronous speed is the lowest value feasible in the majority of cases. The speed cannot be termed adjustable since it is adjustable only at constant torque. Any change of load causes a

change in speed, since, as before stated, the slip depends upon both load and secondary resistance: It is evident that a varying load will give a varying speed. Reduction of load causes increase of speed. With very light loads the slip is greatly reduced and the speed reaches nearly synchronous value. At light loads it is impossible to secure more than a 5 to 10 per cent range of speed control without the use of extremely large resistances. A given setting of the controller will provide a 10 per cent slip at light load and a 50 per cent slip at full load. The speed at any controller position is thus indeterminate and depends entirely upon the load. The method is thus ill adapted to changeable loads except in connection with continuous manual attention. Since the speed of a motor varies widely with load changes it is necessary that the exact amount of load be known if a definite load speed is to be obtained. Overmotoring is not permissible if a definite reduction is desired since the range of obtainable speeds is less, the smaller the load. The characteristics of rheostatic control are well illustrated by the curves in Fig. 7, showing the operation of the wound rotor motor with different secondary resistances.

Since the primary magnetism of the motor remains practically constant, a given torque requires a given secondary current, regardless of the speed or rotor resistance. A motor of this type is a constant torque proposition and its horse power output is reduced at decreased speeds. At full speed, full load, most of the input is converted to mechanical output. At half speed the same input develops but half the mechanical output. The balance of the power is wasted in the secondary resistance. The speed reduction is obtained through heavy sacrifice in efficiency. In general, the efficiency is reduced almost in direct proportion to the reduction in speed. The low efficiency makes this method of speed control ill suited for motors of moderate or large size operating rather continuously at reduced speeds under load. The wastage of power in such cases may be enormous.

Where it is desired to find the efficiency of a wound rotor motor at any given speed, the following method may be applied. On a speed efficiency curve, plot known value of efficiency at full load torque and full load speed. Connect this point with the zero of co-ordinates. The efficiency with full load torque at any reduced speeds may then be read directly from this curve. If the half load maximum speed efficiency is known, a similar line may be drawn to represent the efficiency with this torque at different speed. Fig. 7 illustrates the method as applied to a specific case.

The power factor of the wound rotor motor with rheostatic control is dependent upon the torque, irrespective of the speed and is rather high, being better at full load than at fractional loads.

The same secondary controller and resistance is used both for starting and for speed control. Resistors for speed control service must be different from those designed for starting duty only, as they must have greater heat dissipating ability because of the more continuous service. In other respects the controller as used for speed control is identical with that used for frequent starting and other services.

Rheostatic control is satisfactory for work requiring a low speed for setting up and a higher speed for operating. The low efficiency at reduced speed is here unimportant. It is adapted for use where a very limited speed range is desired and where the load is not of a fluctuating character. It is also applicable for

intermittent service with continuous manual control. There are many uses for this method of speed control but there are likewise many kinds of service where it is not satisfactory. A few typical cases may be mentioned. Rheostatic control is not suited for machine tool drives since the speed range is too limited and the rotation altogether too unsteady. It is not suited to any work requiring fairly constant speed with varying

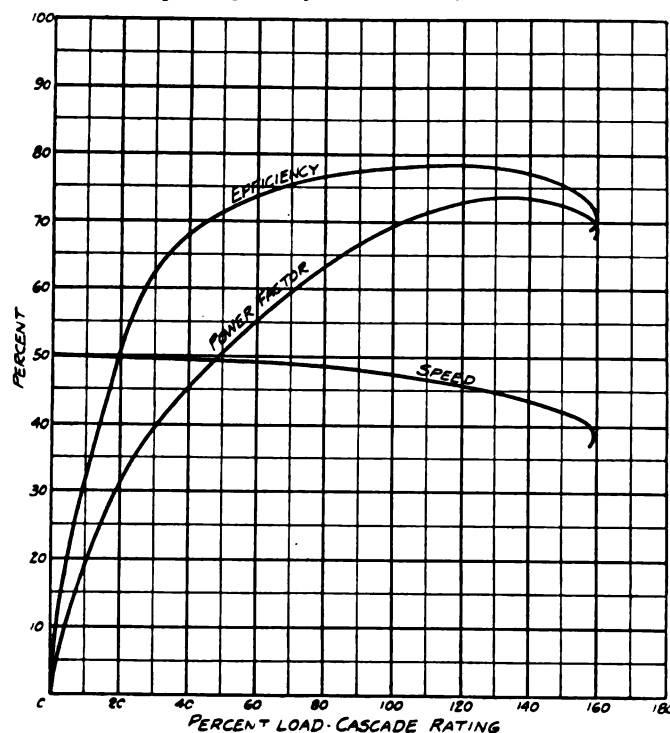


FIG. 6—Dgm. characteristics of a cascade set.

loads. It is not well suited for work requiring full horse power at reduced speeds. It is undesirable for continuous service at greatly reduced speeds because of its low efficiency.

Primary Voltage Control.

The slip of an induction motor with squirrel cage rotor may be varied by changing the voltage applied to the primary windings. The slip, at a given torque varies approximately inversely as the square of the applied voltage. The line voltage may be reduced, to lower the speed, either by means of an auto transformer with taps affording adjustable voltage, or by the insertion of resistance in the primary circuit. The two methods afford slightly differing characteristics.

The torque capacity of an induction motor varies as the square of the applied voltage. A reduction in applied voltage brings about a marked decrease in available torque. At half voltage, the maximum torque has but a quarter of its normal value. The possible range of speed variation is limited by the accompanying reduction in pull out torque. It has been pointed out on previous pages that an induction motor with high resistance rotor exerts a better torque with reduced primary voltage than a motor with low resistance rotor. It also affords better starting torque per ampere. For these reasons, motors for primary control are specially designed having low magnetic leakage and high resistance squirrel cage rotors. The large rotor loss incident to this design makes necessary the use of comparatively large, easily rated frames which are consequently expensive. Auto transformer control

is more complicated and costly than series resistance control and the auto transformer connections must be switched off and on and cannot be short circuited as with resistance control. Auto transformer control affords a higher efficiency than resistance control and takes less current but gives a poorer power factor.

The comparative characteristics of rheostatic control and primary control with auto transformers and

large rotary converters or synchronous motors where the efficiency is of minor importance and simplicity is paramount.

(To be continued)

SOME UNUSUAL METHODS IN WASTE ELIMINATION*

Betterment work in the operation of small central-station companies is receiving widespread attention at present, and various lines of attack on waste are being followed with good results in many parts of the country. The following representative "leads" were noted recently in visiting stations which were trying to make the most of existing equipment as well as to install new and economical generating units and auxiliaries:

Substitution of two Klaxon horns and an individual forge blower for an air whistle and compressor service in station forge shop. This secured a marked reduction in the hours of daily operation of an air compressor.

Measurement of the foot-candles of illumination in various parts of the plant, from the coal pocket to the operating gallery, with a tabulation of desirable intensities and lighting unit sizes.

Check-up of station lighting circuits and switching arrangements to permit reduction of energy consumption in maintaining illumination in sections of the plant periodically but not continuously under close operating observation.

Installation of industrial ash car operated by storage battery to reduce labor of ash disposal.

Provision of plane mirror at proper angle outside boiler room to reflect image of chimney top for convenience of boiler-room force in checking smoke emission and maintaining rules of smoke density laid down by state authorities.

Removal of 6600-volt knife switches from location within 3 ft. of flow line to height of 12 ft., for safeguarding switchboard operator's work at rear of panels.

Concentration of indicating and recording instruments for boiler-room service in inclosed office at central point in boiler house to facilitate control of boiler units, draft, feed water, etc., and more quickly effect changes in handling when inefficient conditions appear.

Analysis of economical load points or range of efficient service by auxiliaries to insure better handling of such apparatus in connection with fluctuations of station output.

Preparation of special log sheet to record interconnection data, routine and emergency service conditions, to insure more accurate permanent records of operation and provide a basis for deeper economic studies of interplant handling.

Provision of glass-inclosed office in old transformer station serving industrial area to reduce amount of heating required in winter as compared with former practice of steam-heating entire building. Group assembly of all transformer-cooling water-supply valves in recess in switch house, with visual indication of rate of flow and massed thermometric facilities under immediate observation of load dispatchers.

*Electrical World.

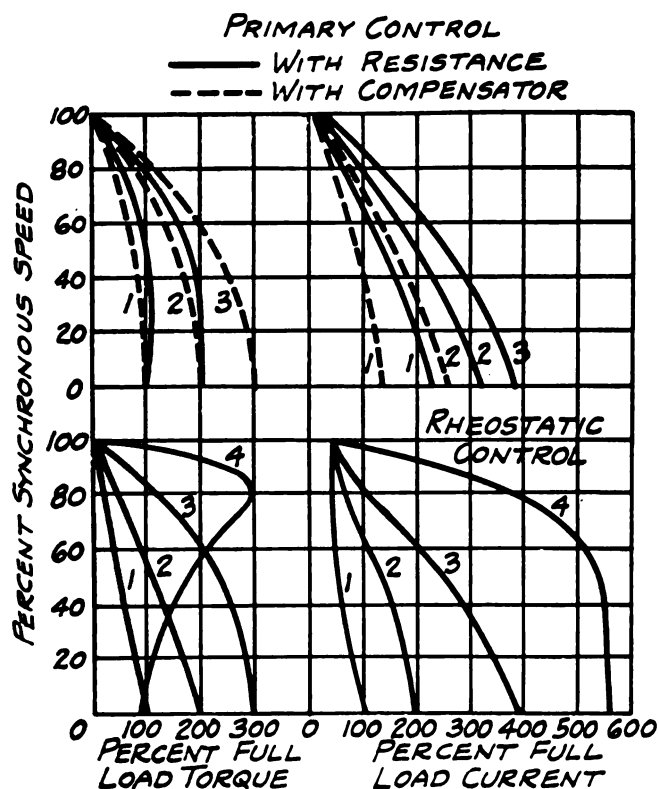
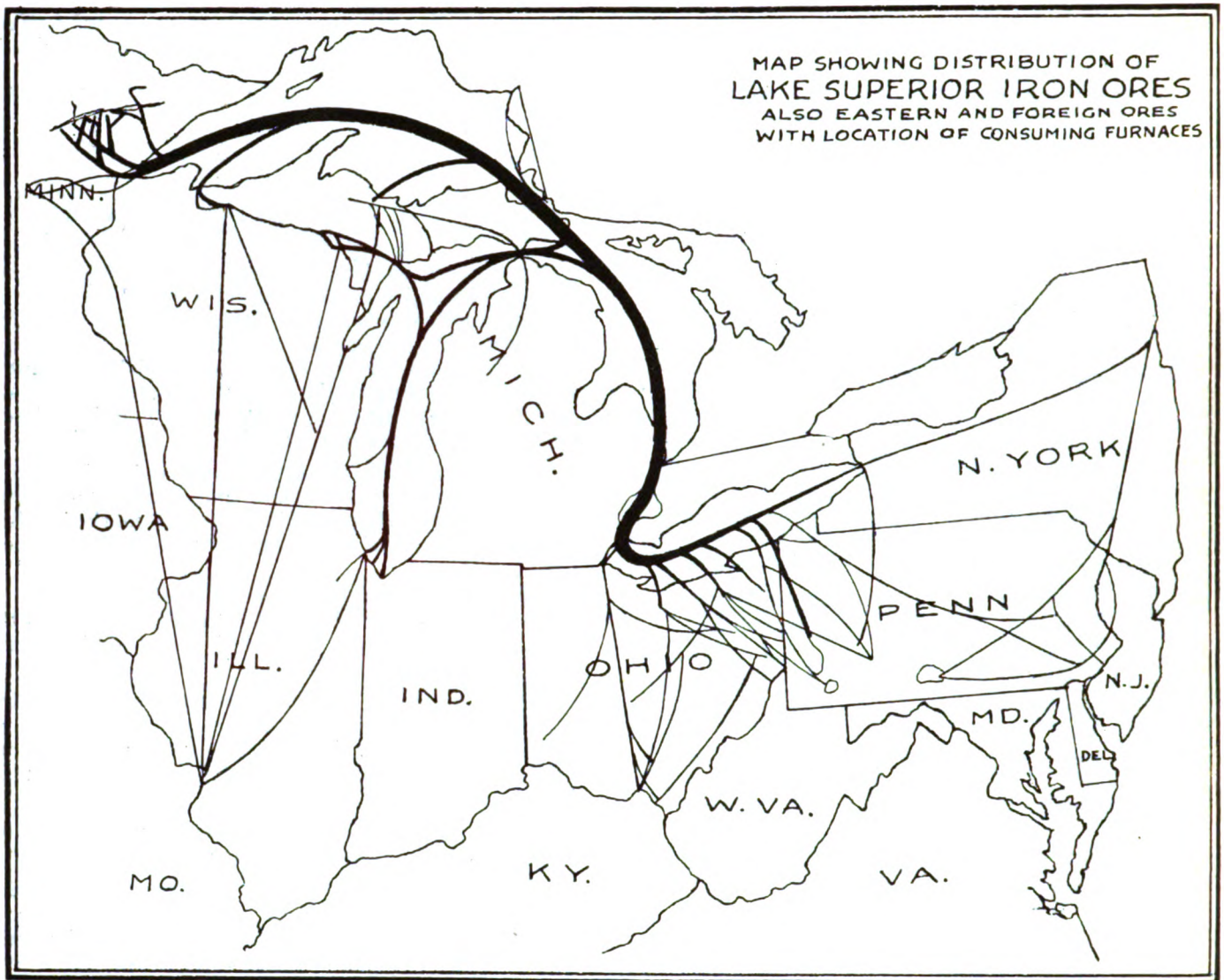


FIG. 7.—Dgm. comparison of primary voltage and rheostatic control methods.

resistances may be studied from Fig. 7. The figure shows typical speed torque and speed current curves for the three methods. Curve 1 gives full load torque at starting. With rheostatic control 100 per cent full load current is taken, with auto transformer control the current is 140 per cent and with series resistance control it is 225 per cent. For starting, it is evident that rheostatic control affords much better torque per ampere. Curve 3 shows the same torque per ampere for all three methods of control. This is because full primary voltage is impressed in all cases and the secondary resistance on this controller point with rheostatic control is equal to that of the high resistance squirrel cage rotor.

The advantages of primary control are the use of the squirrel cage motor with no secondary leads and the simplicity of the primary resistance controller. The disadvantages are: poor speed regulation, low efficiency, a large and consequently expensive motor, small range of possible speeds and rapid reduction in torque at decreased speed. Primary control is used in powder mills and for such cases where explosion or fire might result from a spark at the slip rings of a wound rotor motor. Other applications of primary control are for trolley and traverse motors of cranes, due to the lesser wiring on some elevators and as starting motors for



A GRAPHIC PICTURE OF IRON ORE MOVEMENT

A very interesting and instructive map of the areas covered by northern blast furnace operation has recently appeared in blue print form.

The flow diagram has been proportioned to represent the volumes of ores in transit at various points.

Lake ports are clearly indicated and the many arteries of transportation from the large ports to the different iron and steel manufacturing centers are shown.

Although the volume of ore moved in 1921, which is the year shown, was much smaller than the average, the proportions for a record year would vary but little.

The full size blue print contains a great deal of valuable information, which the reduced cut makes impossible to reproduce.

WAS IRON ORE PIONEER

Charlemagne Tower, Former Ambassador, Dies At Philadelphia.

Charlemagne Tower, once a powerful pioneer figure in the Lake Superior iron ore trade and former resident of Duluth, Minn., died Saturday in a hospital from pneumonia. He was prominent in national politics and

finance, having been for six years ambassador to Germany, being named by President Roosevelt in 1902. Previous to that President McKinley in 1897 named him minister to Austria-Hungary, two years later as ambassador to Russia.

Charlemagne Tower was born in Philadelphia on April 17, 1848, was educated in the public schools of that city, later at Phillips Academy at Exeter, N. H., and was graduated from Harvard in 1872. After being admitted to the bar in 1878 he began to practice, but in 1882 he removed to Duluth to accept the presidency of the Duluth & Iron Range railroad. He also held in conjunction the managing directorship of the Minnesota Iron Company for five years. These properties now are owned by the United States Steel Corporation through subsidiaries. During this period Mr. Tower was largely instrumental in opening and developing the great iron ore deposits in the Lake Superior regions. He originally had inherited a fortune accumulated in the anthracite regions of Eastern Pennsylvania. He married in 1888 Miss Helen Smith of Oakland, Calif., and had three sons. He was honored with degrees by several universities, was a member of the American Institute of Mining Engineers, the Academy of Natural Sciences, a number of historical societies, a former director of the Pennsylvania Steel Company, now a part of Bethlehem Steel Company, and of the Reading and the New Haven railroads.

The Manufacture of Steel

An Interesting Description of the Processes Involved in the Refining of Iron into Steel—Facts Concerning the Production of Open Hearth Steel.

By G. A. REINHARDT*

STEEL is an alloy of iron and carbon, containing other common elements as manganese, sulphur and phosphorus, which although frequently termed impurities, have certain functions to perform. It is almost universally produced in the liquid state, cast into molds and if it contains at least 0.20 per cent carbon, is capable of hardening upon sudden cooling.

Steel is now produced by refining pig iron, but was, in the early days, made directly from iron ore by treating it with charcoal upon the hearth of a forge, known as a "Catalan Forge." The product was, however, of irregular composition and uncertain quality. This method of manufacture was later superseded by indirect methods, in which the iron ore was first smelted to pig iron in the blast furnace. Pig iron, converted into steel in subsequent operations, contains about 90 to 94 per cent iron, 3 to 4.5 per cent carbon, 0.5 to 2 per cent silicon, 0.5 to 1 per cent manganese, 0.05 to 3 per cent phosphorus and 0.02 to 0.07 per cent sulphur.

After this period and until about the middle of the past century, pig iron was refined only by hand puddling in small reverberatory furnaces lined with iron ore, producing "wrought iron." Wrought iron is pure iron containing fibers of slag. Its approximate chemical composition other than its iron content is as follows:

Carbon	Less than 0.04 per cent
Manganese	Less than 0.10 per cent
Sulphur	Less than 0.05 per cent
Phosphorus	0.30 per cent and less
Silicon	0.10 to 0.25 per cent

These elements are principally combined with each other to form the slag. Until the introduction of Bessemer steel, wrought iron was used for structural purposes; but because it was not capable of being hardened by heat treatment, it was unsuitable for the manufacture of tools.

To fill this need the first indirect process, that of producing "blister" or "cementation steel" was developed. In this process high grade wrought iron bars and charcoal are packed into heating furnaces in alternate layers and heated until the iron has absorbed the desired amount of carbon. In about two days the temperature has reached a full red heat and this is maintained one or two weeks longer, depending upon the grade of steel desired. The product is controlled by a series of trial bars which are so placed that they may be withdrawn from the furnace from time to time, broken and examined for depth of carburization. When the process has proceeded to the desired degree the fire is withdrawn, the furnace allowed to cool, and the bars removed. The carbon absorbed reacts with the slag present in the iron, producing gases which raise blisters on the surface of the bars, from which the steel derives its name.

*Metallurgist, Youngstown Sheet & Tube Company, Youngstown, Ohio.

The bars of blister steel are then forged to desired sizes, piled, welded and forged down into a product called "single shear steel;" the latter is sometimes repiled, welded and forged, producing what is termed "double shear steel."

Cementation steel is not uniform throughout, the carbon being highest near the surface, gradually diminishing toward the center of the bar; it also contains slag, seams, and other defects, inherent in the wrought iron, which render this steel undesirable for the manufacture of high grade tools. To eliminate these defects, bars of blister steel are cut into small pieces charged into crucibles, protected from the air, and melted; after which they are cast into molds and forged or rolled into bars known as "crucible steel." The more modern and less costly process for making crucible steel is to melt bar iron or low carbon steel bars in crucibles with charcoal, since carbon is more rapidly and homogeneously absorbed by the liquid metal. At present the crucible process is only used for the manufacture of very high grade tool steels where cost is of secondary consideration.

The first great advance in the manufacture of steel, and the step that brought it into common use for railroad and structural purposes, permitting the great industrial development which followed its invention, was a pneumatic process. In 1846 William Kelly discovered his pneumatic process of making "malleable" iron from pig iron, at the Suwannee Iron Works near Eddyville, Ky. Patents for converting pig iron into steel by a pneumatic process were granted in Great Britain to Sir Henry Bessemer in 1855 and, although Kelly did not apply for patents until 1857, almost two years after the Bessemer's English patent was granted, his application was allowed in the United States on ground of priority.

This process, now universally known as the "Bessemer process," consists of blowing air through a bath of molten pig iron. This operation purifies iron by oxidizing its silicon, manganese and carbon content. The process is conducted in a large vessel called a "converter," supported on trunions, so that it may be rotated in a vertical plane. It is lined with a suitable refractory material. The bottom of the vessel is removable and in it are set 18 to 30 tuyeres having 12 to 18 holes ranging in size from $\frac{3}{8}$ in. to $\frac{5}{8}$ in. diameter. Attached to the bottom of the converter is a "windbox" connected with the air supply through a hollow trunion. By this means air is blown through the tuyeres and upward through the molten metal, producing combustion of the silicon, manganese and carbon contained in the iron. The process is conducted as follows: The vessel is rotated to a horizontal position and molten iron is poured in from a ladle, the blast is turned on and the vessel rotated to a vertical position; the silicon and manganese are removed in 4 to 7 minutes; the carbon becomes oxidized after $2\frac{1}{2}$ to 3 minutes and is eliminated in about 10 minutes. After the removal of carbon the vessel is again turned to a

horizontal position and ferro-manganese added, which serves to remove the oxides held in the bath and to add the required amount of carbon to the steel. The Bessemer process did not prove a success until David Mushet suggested the addition of manganese as a deoxidizer, for which he was granted an English patent, September 22, 1856. There are two forms of the Bessemer process, the acid and the basic; one or the other of these modifications is used according to the nature of the available iron.

The acid Bessemer process is used exclusively in the United States. In this process an acid lining is used and an acid slag, incapable of removing either sulphur or phosphorus, is formed. For this reason iron low in these elements is required. The usual limits for chemical composition of acid Bessemer pig iron are:

Silicon	1.00 to 2.00 per cent
Manganese	0.40 to 1.00 per cent
Sulphur	0.07 per cent maximum
Phosphorus	0.10 per cent maximum

The basic Bessemer process differs from the acid in that the lining of the converter is of basic material and a certain amount of lime is added to the charge to produce a basic slag for the removal of sulphur and phos-

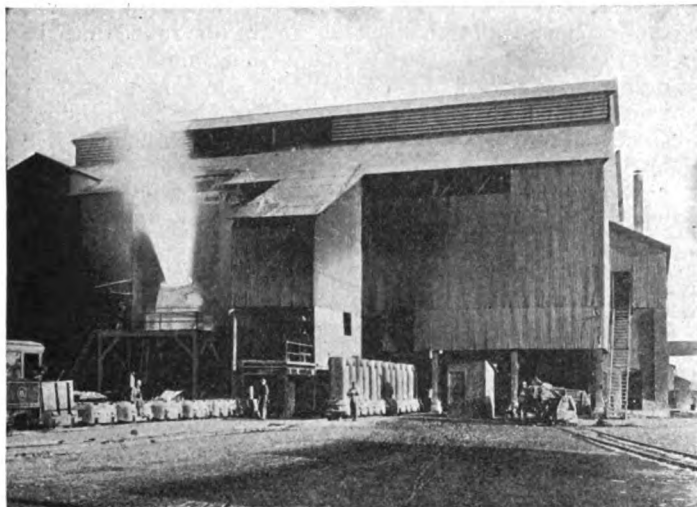


FIG. 1—Shows a typical Bessemer converter in operation.

phorus. The vessel must be larger than an acid converter of equal capacity, on account of the increased amount of slag. The usual limits of composition for basic Bessemer pig iron are:

Silicon	1.00 per cent maximum
Manganese	0.30 per cent to 2.00 per cent
Sulphur	0.30 per cent maximum
Phosphorus	2.00 per cent maximum

The basic process is divided into two distinct stages. The first, called the "foreblow," is characterized by the oxidation of silicon, manganese and carbon and corresponds to the ordinary blow of the acid Bessemer. The phosphorus and most of the sulphur are removed in the second stage, called the "after-blow." The time required by the basic process, about 18 minutes, is almost double that of the acid process. The recarburizer is added to the ladle after most of the slag has been skimmed off, to prevent the reduction of some of the phosphorus and its restoration to the metal.

The invention of the regenerative furnace in 1861, by Sir William Siemens, rendered possible attainment

of the high temperatures required for steel making and led to the development of the open hearth process. Like the Bessemer process and for similar reasons, it is divided into both basic and acid; the basic process being in more common use in the United States.

The open hearth furnace is a relatively large reverberatory furnace with a shallow hearth; provided with ports at both ends, charging doors for the introduction of the charge at the front side and a tapping hole for the removal of the steel on the rear side. The furnace is charged with steel scrap and pig iron; the process started by admitting preheated gas and air through the ports at one end. These burn within the hearth chamber; the charge is heated both by radiation and by heat reflected from the walls and roof of the furnace. The regenerative principle is carried out in large chambers provided with checker work of fire brick. A pair of these are connected with each end of the furnace and through dampers or valves all are connected with a stack. The burned gases are drawn through the pair of chambers connected with one end of the furnace by the stack draft and a large part of their heat is taken up by the checkers. Upon reversal of the draft, the air and gas are passed through the heated chambers and absorb heat. In the meantime the burned gases pass through the other pair of chambers, heating them. By reversing the direction of the current at regular intervals, the necessary temperature may be maintained.

In the basic process, a basic slag is required to remove phosphorus and sulphur, and to resist its corrosive action the hearth must be lined with basic material. The charge consists of lime, iron ore, steel scrap and pig iron. The amounts of silicon, manganese and carbon in the charge are considerably reduced during the melting down period which consumes the first 4 or 5 hours. Phosphorus remains practically unaffected until the end of this period, after which it oxidizes rapidly. After the metal has been sufficiently refined, it is withdrawn, through the tap-hole at the back of the furnace, into a ladle. Here the deoxidizers and recarburizers are added as the metal flows into the ladle. This ladle is carried over a train of ingot molds and the steel "teemed" or poured, into these, through a nozzle in the bottom of the ladle. The total time required to make a heat of steel by this process is from 8 to 12 hours. The first basic open hearth furnace was built in this country by the Otis Steel Company, Cleveland, Ohio, in 1886.

The acid open hearth process differs from the basic, in that acid refractories are used for linings instead of basic, permitting the use of acid slags. As in the acid Bessemer process, only iron low in phosphorus and sulphur can be used. The time required for this operation is shorter than that of the basic process and deoxidizers and recarburizers are added to the bath in the furnace.

A combination of the acid Bessemer and basic open hearth processes is known as the "Duplex" process. The advantage of this lies in the fact that the silicon, manganese and carbon of the molten pig iron are eliminated by the acid Bessemer process in a very short time, leaving only sulphur and phosphorus to be removed by the basic open hearth process. By this means, steel may be produced in about one-half the time required by the basic open hearth process. It is especially adapted to refining pig iron with a high phosphorus content, over 1.00 per cent, but too low for the basic Bessemer process. These conditions prevail in the southern iron regions and led to the adoption of the duplex process by the Tennessee Coal, Iron & Railroad Company in 1904.

All processes for steel making depend upon the oxidation of certain constituents of pig iron at elevated temperatures and suitable flux to form slag for their removal. In the Bessemer process the temperature required for this reaction is obtained by the combustion of the elements eliminated, while in the open hearth process the temperature is produced by the combustion of suitable fuels. In recent years, the temperature necessary to produce these refining reactions has been obtained by the use of electrical energy, in metal jacketed furnaces lined with acid, basic or neutral refractories. Inasmuch as combus-

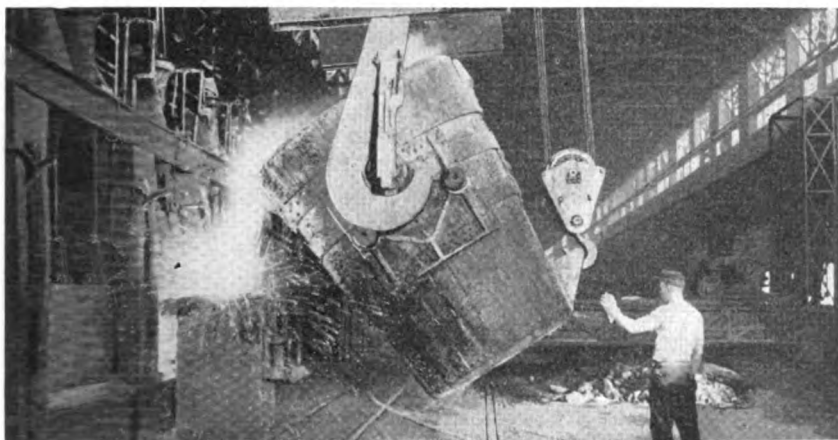


FIG. 2—A spectacular feature of steel making, pouring open hearth ingots.

tion of fuels is not required in this process, oxidizing, reducing or neutral atmospheres may be maintained. By devices for controlling the electric current, the resulting temperature may be more easily manipulated than in any of the above processes. Steel equal to the best grades of crucible steel can be produced in the electric furnace; some high grade steels are made by a process also termed "duplexing," which is a combination of the basic open hearth and the electric furnace. The electric process has many advantages in its favor, but its chief disadvantage is the high cost of operation and maintenance.

POSSIBILITIES FOR THE DEVELOPMENT OF THE IRON AND STEEL INDUSTRY IN ARGENTINA

To an American, familiar with Argentina, it appears strange indeed that up to the present time so little has been accomplished in the development of a domestic iron and steel industry. Especially is this true when we remember that the Jesuit missionaries, as far back as the 17th century, manufactured iron utensils from ores mined in Cordoba. Moreover, this is stranger still when upon investigation we learn that nearly all of the known iron ore deposits in the Argentine are to be found in close proximity to coal or waterfalls, where abundance of electric current could be generated.

No doubt the principal reason for the neglect of this industry has been the inclination of Argentines to follow the line of least resistance; that is, to take advantage of their fertile soil and splendid climate to develop an essentially agricultural and pastoral country. Also the scantiness of population, the lack of capital, and the want of technically trained miners have acted as a deterrent to the development of this industry. However, the determining factor in holding back progress

along this line has been the scarcity of railroads in the mining districts of the country and the high cost of transportation over existing lines from mining regions to the centers of industry and commerce.

The \$50,000,000 spent by Argentina annually in the purchase of iron and steel goods imported into the country without taking into account the cost of supplies for State Railways, gives one an idea of the immense saving which could be effected through the exploitation of Argentina's iron mines. Due to the pressing necessities brought about during the war on account of the restriction of ocean traffic, many large iron foundries sprang up in Argentina where scrap iron was used as the principal raw material in the manufacture of many articles which could not be secured from abroad. Thus, industrially speaking, Argentina is equipped to produce all the iron and steel required in construction works; likewise, for the manufacture of agricultural implements; steel rails and car-wheels; galvanized iron sheets, which, once the zinc mines of the country were exploited might be converted into tin plate, saving the country many millions of dollars yearly and creating a profitable industry which in a certain sense would free the country from an economic dependence upon foreign factories for metallic containers required on such a large scale for all classes of

Argentine canned goods. At the same time a creation of a domestic tin plate industry would make possible the development of Argentine fisheries, which has not yet taken place, in spite of exceptionally favorable conditions because of the high cost of containers.

Contrary to what has taken place in many other countries, Argentina now has the industrial plant before securing a domestic supply of ore, because it must be remembered that scrap iron is only considered as a substitute. Be this as it may, the industrial equipment of Argentina may be considered as a glowing tribute to the efforts of private enterprises and certainly the National Government itself should make an effort to develop domestic sources of supply of the raw materials. It is interesting to note that during the last two years Argentina's importation of iron and steel has increased more than \$10,000,000. If we make exception of complicated machines and high tempered steels, which make up but a small portion of Argentina's imports, everything else can be manufactured in the country with Argentine iron ores since an innumerable list of articles are now made through the use of scrap iron.

Certainly the time is ripe in Argentina when a definite step forward in this important industry should be made, and we are convinced that American iron and steel manufacturers would do well to investigate the possibilities offered them for securing valuable concessions which will enable them to build up along the River Platte an iron and steel industry of great magnitude.

Dr. William D. Harkins, professor of Physical Chemistry at Chicago University, will give a course of three technical lectures March 19, 20 and 21 at Carnegie Institute of Technology, Pittsburgh. The engagement of Dr. Harkins is in line with the policy of the Institute to secure leading scientists in various fields to lecture before Pittsburgh industrial interests.

Comparison of Sand Cast and Machine Cast Pig Iron

Economic Effects—Melting and Spout Temperatures—Differences in Melting Conditions Noted.

By S. B. PHELPS*

THERE has been considerable difference of opinion on the relative merits of chilled pig iron and sand pig ever since the introduction of the machine casting method about 25 years ago. The chilled pig iron has constantly increased in favor among foundrymen in spite of the inability to mix or judge its quality by fracture. The writer believes that this is the most practical point in favor of the sand cast pig today through the value of this characteristic lies chiefly in enabling the foundryman to identify such irons by fracture without waiting for a check analysis when the yard laborers lose or misplace the analysis markings on the piles of pig.

More Research Needed on Irons.

Foundrymen are usually placed at a disadvantage in trying new products because they are seldom given sufficient facts on which to base their decisions. This applies not only to a lack of research on pig irons even today but to all phases of foundry practice and to all materials. The critical machinist might be surprised to learn that if every foundryman knew all facts discovered by foundrymen and scientists they would not be sufficient to enable him to produce perfect castings continually. The foundrymen's resourcefulness must still be relied upon to overcome the difficulties which science has not yet explained.

Economic Effects.

Consideration for the general prosperity of the foundries and allied industries as well as national emergencies make it important for foundrymen to investigate and compare the merits of both types of pig iron regardless of any natural preference for either type.

During the war it was frequently impossible for American foundrymen to obtain pig iron of proper analysis for their mixtures and reputations for castings of quality were injured, regardless of this cause, for foreign buyers especially never know such details. Inability to get sufficient pig iron of the desired analysis when a shortage exists or when transportation is restricted certainly should not be further complicated by insisting on securing iron cast by one method regardless of the freight haul.

Casting Sand Pigs from Chilled Pigs.

The reduction of the grain size by the chilled molds is no handicap today as almost all mixes are made or regulated by analysis, but should the foundryman wish to know the fracture of chilled pig iron he can easily determine it by making special charges of the pig at the beginning of the heat and simply pouring it into sand pig molds. In testing new brands the writer

frequently used a shrinkage test piece with a cross section approximately equal to a pig. A sand pig cast from chilled pigs would have a closer grain due to the oxidation of about .25 per cent of silicon and a grain in sulphur. The result, however, would be practically the same as if sand cast pig had been tested. The foundryman must discount these changes made by the cupola when mixing by fracture so that is no objection to such a test.

Melting and Spout Temperatures of Sand and Chilled Pig.

The fact that sand cast pig cools slowly and causes most of the carbon to separate as graphite whereas chilled pig restrains the carbon in the form of combined carbon (Fe_3C) is of interest because the melting point is influenced by the amount in the combined form as well as the total carbon. According to Wurst and Peterson the freezing points range from 2102 deg. F. for an iron of 0.75 per cent silicon and 4.02 total carbon to 2199 deg. F. for an iron of 4.00 per cent silicon and 3.24 total carbon. This gives a range in the melting point due to the total carbon in foundry brands of about 100 deg. F. Dr. Moldenke in his excellent book, "The Principles of Iron Founding," gives 1990 deg. F. as a minimum melting point for white irons and 2280 deg. F. as a maximum melting point for gray iron varieties or a difference of 290 deg. F. for the 63 specimens tested in his investigation to prove that combined carbon lowered the melting point of iron.

Machine cast pig undoubtedly melts at a lower temperature than sand cast pig of similar analysis and probably regardless of the analysis for foundry grades. This fact together with some observations of molten iron has caused some foundrymen and metallurgists to believe that machine cast pig produces hotter iron.

It seems that almost anything can be proved from a cupola. Cupolas and cupola practice varies widely because of the practical necessity of foundries being required to use scrap of more or less irregular size and analysis together with the variations of the volume of air blast. The operation of cupolas by laborers to a large extent does not tend to produce uniform results either. Even under ideal, practical conditions the cupola does not permit scientific results of laboratory exactness. The writer has at times observed by eye considerable changes in temperature during the heat and has noted variations of about 100 deg. F. with an optical pyrometer after the lining had become heated and before there had been any chance for slag to interfere with the blast and otherwise conditions were practically uniform. This condition probably is caused by temporary interference with the blast by the charges.

*Member American Foundrymen's Association.

Some consider that sand cast pig produces hotter iron because it absorbs more heat before it melts due to its higher melting temperature. Sand cast pig must of course absorb more heat than chilled cast pig but in doing this it sinks lower in the cupola than chilled cast pig. The molten drops of chilled pig therefore fall a greater distance through the hottest region of the cupola than the sand cast pig with the result that the radiation from the incandescent coke has a longer time to superheat the molten drops from the chilled pig. As the transfer of heat by radiation is much more effective than by conduction the advantage should be in favor of the chilled pig especially as the total drops melted from a pig present a greater surface to radiation than the surface of a solid pig. The writer believes that, whether the two conditions mentioned just balance or not there is no practical difference in the cupola spout temperatures of sand cast or chilled pig with similar total carbon content.

It is not to be expected however, that a mixture of both kinds of pigs in the same charge will give such uniform results as a mix made from one type of pig. For conditions not very exacting the loss of chilled pig in each charge, after the first one, is compensated somewhat by the addition of molten iron from the chilled pig in the following charge. A mixing ladle, forehearth, or a reasonable quantity of molten metal held in the cupola before tapping also assists in giving more uniform iron when one type of pig cannot be used exclusively in the mixtures.

Undoubtedly, chilled pig is to be preferred to sand cast pig if it were only to avoid the excess slag produced by the sand clinging to the pigs. The sand increases the danger of slag inclusions, causes considerable difficulty in long heats in its removal from the cupola, interferes with the blast and therefore tends to cause uneven melting and dull iron. The resulting defects and losses in castings not only affect the foundry but also the machine shop.

Types of Pipe Joints*

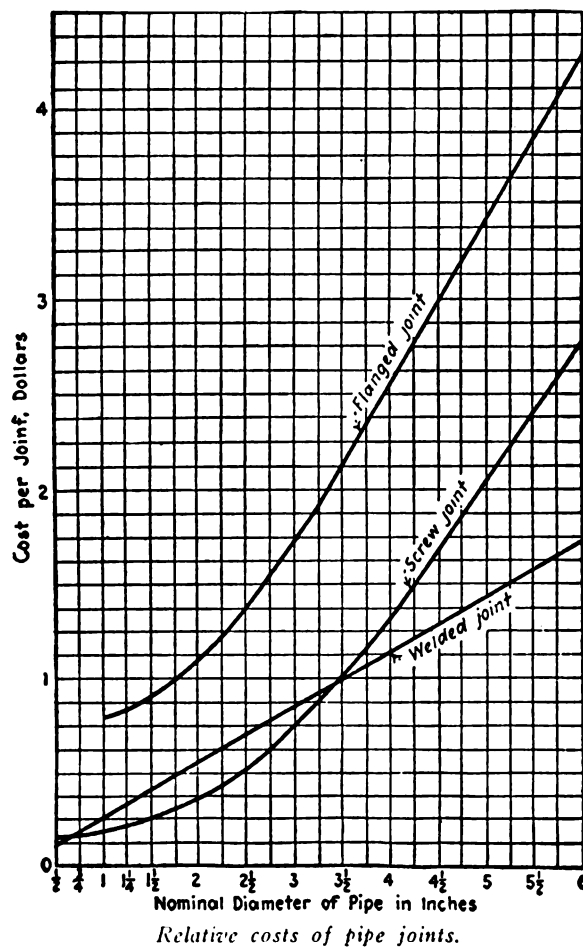
Suggestions of Comparative Costs Shown in Diagrams Which Will Assist in Choice of Joint to Be Used.

THE accompanying curves show the cost of fitting pipes in power plants, with flange fittings, screw fittings, and welded joints, based on the cost per joint, which includes cutting two threads, fitting two flanges and bolts in the case of the flange fittings, or screwing and coupling in case of the screwed fittings.

It will be noticed that for sizes under $3\frac{1}{2}$ in. the cost per joint in the case of welded pipe is a little more than the cost of screwed fittings until the smaller sizes are reached, where the two costs run about equal. For sizes $3\frac{1}{2}$ in. and larger there is a material saving in cost, due to welded joints. In comparison with flanged fittings the saving is considerable for all sizes, averaging close to 50 per cent in the 1-in. to 6-in. sizes. However, the saving is not all in the first cost of the fittings, but by eliminating threaded joints much longer life and less maintenance can be expected. This is especially true of long lines, such as air distributing lines running through shops and car repair yards. The weakest point of a threaded

pipe is at the threads—that is, so far as length of life is concerned. It is here that corrosion first takes place, which in a short time results in leakage of air or steam, or other contents of the pipe.

Two methods of welding pipe are suggested: One, a butt weld, in which the pipe is carefully faced on the end, and in some cases scarfed; and second, a lap weld, made by using a sleeve, similar to a coupler without threads, slipped over the joint and the sleeve welded to the pipe at either end. Where the latter method is used, special fittings such as tees and ellis could be made up



economically on a production basis when the demand for such fittings became sufficiently large. When the butt weld is used, great care must be taken to prevent the formation of fins inside the pipe that obstruct the flow. With the sleeve type of weld such obstructions are obviated and greater strength is given to the pipe at the point of the weld.

It is to be understood that no definite recommendations are made at this time for the welding of pipes. However, the possibility of saving by the use of welded instead of flanged or screwed joints, is great. This applies to the smaller size pipes, 6-in. and under, where pressures are comparatively low—say, not to exceed 150 lbs. For power plant work, where high pressure headers are used, a different method of welding would have to be adopted.

When it is considered that these pressures now exceed 500 lbs. per sq. in., involving 700 deg. temperature in the steam, and that investigations are in progress looking toward even higher pressures, the potential value of welding correctly done appears in most favorable light.

*Mechanical World, Excerpt from Annual Report, American Railway Association.

Alloy Steels in Motor Car Manufacture

The Development of the Present Day Reliable Automobile Has
Been Closely Related to and Dependent Upon Production of Alloys.

By THE EDITOR

SINCE the earliest days of the automotive industry, steels containing nickel have played an important part in the successful construction of cars. As the properties of the nickel-bearing steels have become better known by engineers and metallurgists their use in this industry has steadily been extended. Today there is no motor car or truck manufacturer in this country who does not utilize these steels in some manner in the construction of his product; many use them almost exclusively for all alloy steel parts.

Effect of Nickel on Steel.

The addition of nickel to steel produces a number of improvements in its properties by reason of certain specific effects which it exerts on the structure of the steel:

1—Nickel dissolves in solid solution in the ferrite of steel and thus increases its hardness and strength without corresponding loss of ductility. Nickel steels, of all alloy steels, are unique in that they are used both in the heat treated and in the unheat-treated state.

2—Nickel depresses the critical temperature or heat treatment range of steel.

3—Perhaps partly by reason of (2) the presence of nickel in heat treated sorbitic steel increases the elastic limit and hardness without decrease of ductility; in other words, nickel increases the toughness of heat treated steel.

4—Nickel exerts an influence on the grain size of ferrite and pearlite, tending to produce a finer grain structure and finer pearlite, shading into sorbite. In the same sense it diminishes the rate of grain growth within the heat treatment temperature ranges and thus minimizes the danger of overheating during heat treatment.

These properties, both singly and in combination, are taken advantage of in several ways in metallurgical design.

The depressed critical range enables the use of lower temperatures in the heat treatment of nickel steel. This, of course, means conservation of fuel and longer life of the heat treating equipment.

It is also well recognized that the lower quenching range induces less warpage. The low hardening range of nickel steel in part explains its great popularity as a gear steel in these days when the requirements for quietness in transmission and rear axles are very exacting.

Since nickel increases the strength of steel without corresponding loss in ductility in the annealed or in the rolled or the drawn state, it is especially suited for difficult and important stampings to be used either as drawn or in the heat-treated condition. This feature also makes its use popular in the cold-drawn condition for important bolts used without heat treatment in order that the threads may be in perfect condition, as well as for studs,

nuts, keys, etc., and in the form of $3\frac{1}{2}$ per cent nickel tubing for propeller shafts, axle tubes and other structural parts.

In the heat treated condition its superiority is well recognized for use in difficult construction where high physical properties are required. It is in this state that the high nickel content steels, and those with nickel in combination with various other alloys, give the engineer and the metallurgist, who selects the proper analysis and heat treatment, a wide range of possible physical properties to meet successfully almost every engineering requirement of tensile strength, elastic limit, ductility, hardness, and resistance to abrasion, shock and fatigue. In this condition we see it used in important forgings, axle beams, steering knuckles and arms, levers, axle shafts, gears, cam-shafts, piston pins, etc.

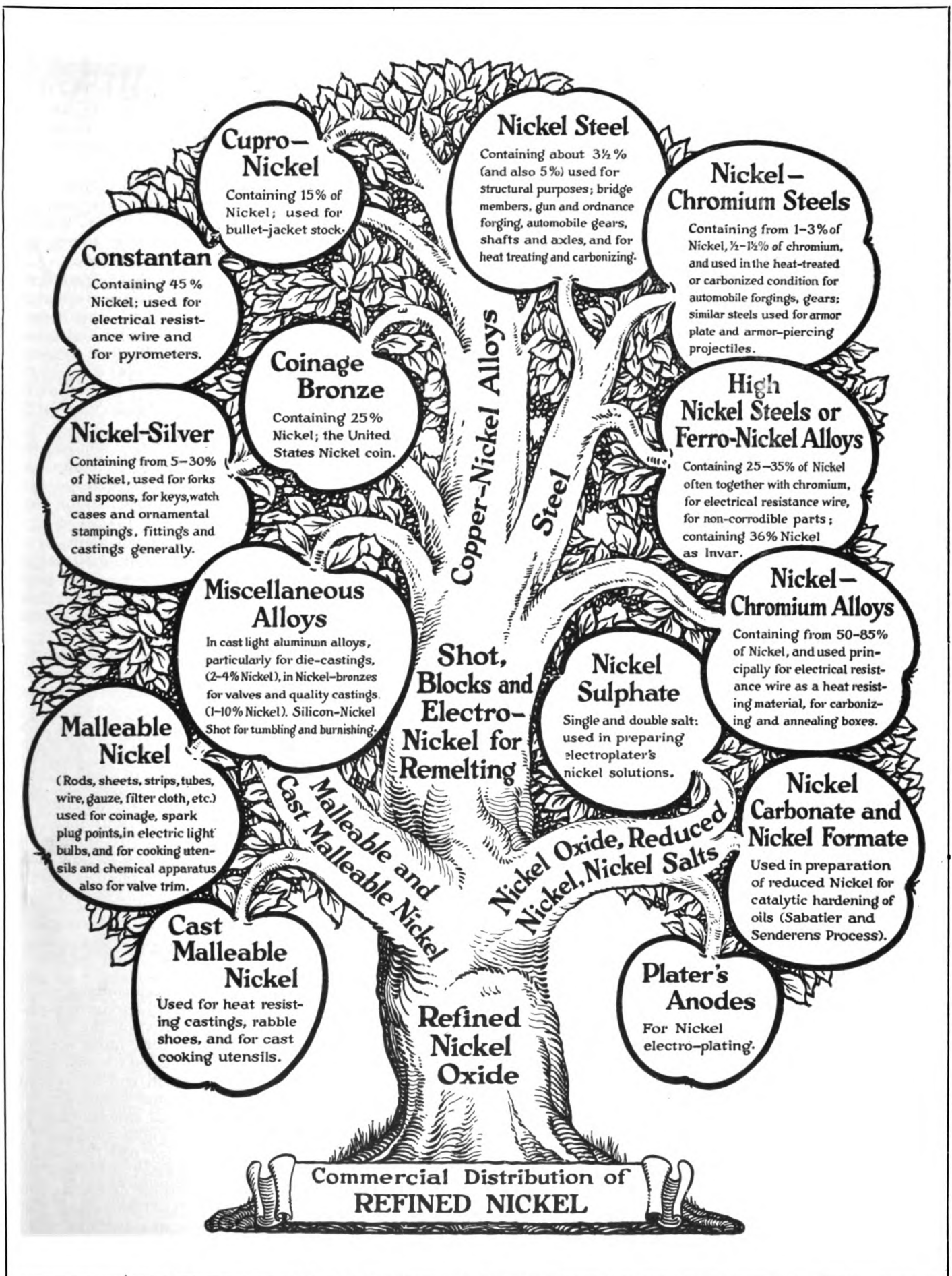
Nickel steels are an almost indispensable material for case hardening or carburizing. The penetration of carbon in nickel steel is very uniform, causing the surface to be free from soft spots; and the presence of nickel makes the case harden easily with an oil quench. These effects are brought out with even small percentages. The presence of nickel in the hard case insures its toughness and resistance to abrasion. The straight nickel steel especially will stand much abuse in grinding without checking or cracking the case.

The effect of nickel in producing a small grain-size and retarding the grain growth at carburizing temperatures, results in an extremely tough and strong core. This effect is sufficiently pronounced to make it possible in many places, where the higher nickel steels ($3\frac{1}{2}$ per cent and over) are used, to omit the high temperature quench; this is especially true if the carburizing temperature is fairly low.

Nickel-Bearing Steels Are Standard.

The use of nickel steel in the automotive industry has been so broad and experience with it has extended over such a long period, dating back to the infancy of the industry itself, that the compositions used have become well standardized both by users and steel manufacturers. Specifications are published, both by the Society of Automotive Engineers and by the American Society for Testing Materials, covering grades of nickel-bearing steels used in the automotive industry.

In consequence, nickel steels are readily secured even on short notice, as they are produced by all alloy steel mills, who consider the $3\frac{1}{2}$ per cent nickel and low chrome-nickel steels as standard heats. They are carried as standard stock by many of the steel warehouses and large drop forge companies. The ease with which these standard steels may be secured has often prevented serious tying up of large production. Through long experience, the steel makers are more familiar with the technique required to produce a high quality of nickel alloy than of any other alloy steels. This, of course, guarantees uniformity of product and freedom from



trouble both in shop fabrication as well as in the finished product.

Standard Automobile Nickel-Bearing Steels.

($\frac{1}{2}$ to $1\frac{1}{2}$ per cent Nickel—.15 to .25 carbon)—Used as a substitute for straight carbon steel in case hardened parts due to toughness of core and better hardening properties which make it easier to handle than the straight carbon.

SAE-3120 (Nickel—1 to $1\frac{1}{2}$ per cent, Chromium—.045 to 0.75 per cent, Carbon—.015 to 0.25)—Widely used for case hardening such parts as pivot pins, steering ball joints, spring shackle bolts, differential spiders, steering gear and worm; also some use in transmission, rear axle and differential gears.

SAE-2315 (Nickel—3.25 to 3.75 per cent, Carbon—.10 to 0.20) and 2320 (Nickel 3.25 to 3.75 per cent, Carbon—.015 to 0.25)—These $3\frac{1}{2}$ per cent nickel steels widely used in all places mentioned in above paragraph and all case hardened gears, transmission gears and shafts, rear axle gears and pinions, differential parts, cam shaft, valve tappets, piston pins, etc.

SAE-3135 (Nickel—1 to $1\frac{1}{2}$ per cent, Chromium—.045 to 0.75 per cent, Carbon—.030 to 0.40) and 2330 Nickel—3.25 to 3.75 per cent, Carbon—.025 to 0.30).—Used in such places as front axle (centers), steering knuckles, crank shafts, connecting rods; also in dead rear axle of trucks. Cold drawn they are used for bolts, studs, nuts, and keys. In sheets, used in important stampings, frames, cross members. As tubing, $3\frac{1}{2}$ per cent nickel finds wide use for front axle tubes, propeller shaft tubes, rear axle housings, and frame torsion tubes. Also used to some extent for valves.

SAE-2345 (Nickel—3.25 to 3.75 per cent, Carbon—.040 to 0.50), 2350 (Nickel—3.25 to 3.75 per cent, Carbon—.045 to 0.55).—Wide for heat treated transmission gears, a scleroscope hardness even of 70 to 90. At this hardness nickel content maintains sufficient ductility to successfully withstand clashing of teeth in sliding gears, and, at the same time, is sufficiently hard to resist the wear.

SAE-3245 (Nickel—1.50 to 2.00 per cent, Chromium—.090 to 1.25 per cent, Carbon—.040 to 0.50 per cent, and 3250 (Nickel—1.50 to 2.00 per cent, Chromium—.090 to 1.25 per cent, Carbon—.045 to 0.55).—Medium nickel-chromium steel develops higher physical properties than the low nickel-chromium, and is used in gears where requirements are severe and unit pressures run high.

SAE-2512 (Nickel—4.50 to 5.25 per cent, Carbon—(Maximum) 0.17).—Used for case hardened parts where requirements are extremely severe, as in rear axle pinions with spiral bevel teeth. One company by using a 5 per cent nickel with approximately 0.45 carbon is hardening transmission gears by heating to 1325 deg. F. and cooling in air.

SAE-3300 Series—(Nickel—3.25 to 3.75 per cent, Chromium—1.25 to 1.75 per cent) and 3400 Series—(Nickel—2.75 to 3.25 per cent, Chromium—.060 to 0.95 per cent).—The nickel-chromium steels conforming to the above analysis, as well as other combinations, are used where high physical properties are required: in the low carbon contents for case hardening purposes; in the medium carbon for forging purposes, axle shafts, and in the higher carbon for heat-treated gears. There is no definite practice established in their use, the choice of analysis seems to be largely a matter of individual requirements.

CUTLER STEEL PLANT, CUMBERLAND, MD.. TO BE READY FOR OPERATION SOON

Installing of Electric Furnace Now Nearing Completion — Other Improvements.

The plant of the Cutler Steel Company will be ready to begin operations in about another month, according to announcement made Saturday by one of the officials, as soon as improvements and the installation of machinery, is completed.

The Cutler Steel Company, backed by New York and Pittsburgh capitalists, will manufacture steel and alloy castings of high heat-resisting quality, used in the making of annealing and carbonizing tubes, etc., which will be this company's specialty product.

The erection and installation of the large electric furnace is about completed, the transformers, cables, furnace, etc., having all been set in place. This furnace will have a melting capacity of one ton of high grade steel every hour and a half. Twenty-five thousand volts of electricity will be used in the operation of this furnace. The old open-hearth furnace, erected at the time the building was constructed, will be used in the melting of certain grades of castings.

In addition to the furnace, the installation of other up-to-date machinery is being rushed to completion in order to start the plant at the earliest date possible, which includes a new electric crane, this making three electric cranes in use in the plant.

Included in the improvements at the plant, is the water supply system. A large tank holding 50,000 gallons of water is being erected upon a steel tower at the South end of the plant, more than 90 feet high. A fire extinguisher system will also be operated throughout the buildings from this tank.

Mr. Hoveing, of Pittsburgh, is the superintendent of the company here, while J. B. Allen, formerly of Cleveland, is the factory superintendent and metal expert.

Messrs McQuigg and Nolan of the New York office of the company, and Messrs Foster and Neeley of the Pittsburgh office, were in Cumberland recently and made a general inspection of the plant.

The citizens of New Cumberland will welcome the starting of this new industry which will mean the bringing of a number of new citizens into their midst. It has not been made known as yet as to how many men will be employed there when the plant is running full but it is known that a great number of skilled workmen will be required to operate it.

NEW OHIO PLANT TO OPERATE 530 POUND PRESSURE

The Ohio Power Company, a subsidiary of the American Gas & Electric Company, is preparing plans for a new power station to be erected on the Muskingum River at Philo, Ohio, about nine miles south of Zanesville, and contract has been placed for two 35,000-kw. General Electric turbines, which will be operated at 530 lb. steam pressure and a total temperature of 725 deg. F. at the turbine throttle. A contract has also been placed with the Babcock & Wilcox Company for the boilers, which will be built for 650 lb. working pressure. The boiler units will consist of boilers, superheaters and economizers of the same design as those being installed for the Waukegan Generating Company. It is understood that many new features will be embodied in the design of this station. Sargent & Lundy, Chicago, are the consulting engineers.

Fly-Wheels on Rolling Mill Drives

A Discussion of Various Mill Power Loads, and Rolling Characteristics Which Determine the Advisability of Flywheels for Such Service.

By F. R. BURT*

ALL rolling mill loads are made up of a succession of peaks whose length and intensity are determined by the length of piece, delivery speed, reduction, temperature and various other factors. These peaks overlap more or less, depending on the layout of the mill and the manner of handling the steel.

In determining the size of motor for driving a mill both the root mean square, or equivalent heating load, and the peak loads must be considered. The relative importance of heating and peak loads depends roughly on what percentage of the total passes contain metal simultaneously. On a single roughing stand or a plate mill on which no two passes are filled at the same time, the peaks may be several times as high as the heating load, while on a rod mill finishing train or continuous mill where the whole mill is kept full 85 to 90 per cent of the time the load is practically constant. Between these two extremes there lies a large group of drives such as simple merchant and bar mills, rod mill intermediate trains, sheet mills, etc., where there is more or less overlapping of passes.

The solid lines in Figs. 1 and 2 represent respectively, the loads on a 16-in. two stand rougher and a 12-in. five stand finishing train, when rolling 4 x 4-in. billets to 1/4-in. rounds. Each load diagram covers one cycle, a piece being entered in the mill every 40 seconds.

The average load on the rougher is 378 hp. with peaks of 1390 hp. A motor, however, cannot be applied on the basis of the average hp. on a load of this kind. The heat dissipated in the motor is proportional to the square of the load, hence the heating effect of a cycle is proportional to the square root of the average squares or the root mean square. The R.M.S. value of this cycle is found to be 550 hp.

A 600 hp. motor would be of the proper size to carry this load from a heating standpoint. However, the peaks are so high during the first few passes that undue strains would be placed on a machine of this capacity. A 900 hp. motor would be of about the proper size for this load. It would be subjected to overloads of 10 per cent to 55 per cent each cycle.

This would not make a very desirable installation for several reasons. Both the electrical equipment and the power line would be required to carry sharp high loads, rising from minimum to maximum value almost instantaneously. Due to some factor which has not been taken into consideration, such as cold steel, these loads would occasionally run much higher than calculated. In fact these unforeseen conditions would probably cause shut-down of the mill at times. Besides this, the continuous carrying capacity of the motor would be almost twice as great as required by the R.M.S. load.

*General Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

With the proper flywheel effect, and means of utilizing it, installed in connection with this equipment, the continuous rating of the motor can be very easily reduced to 500 hp. This is 50 hp. less than the calculated R.M.S. value of the cycle, but when the peaks are kept from the motor, the new R.M.S. load will be well below the motor rating.

A flywheel rotating at constant speed contains a certain amount of energy. In order to give up a por-

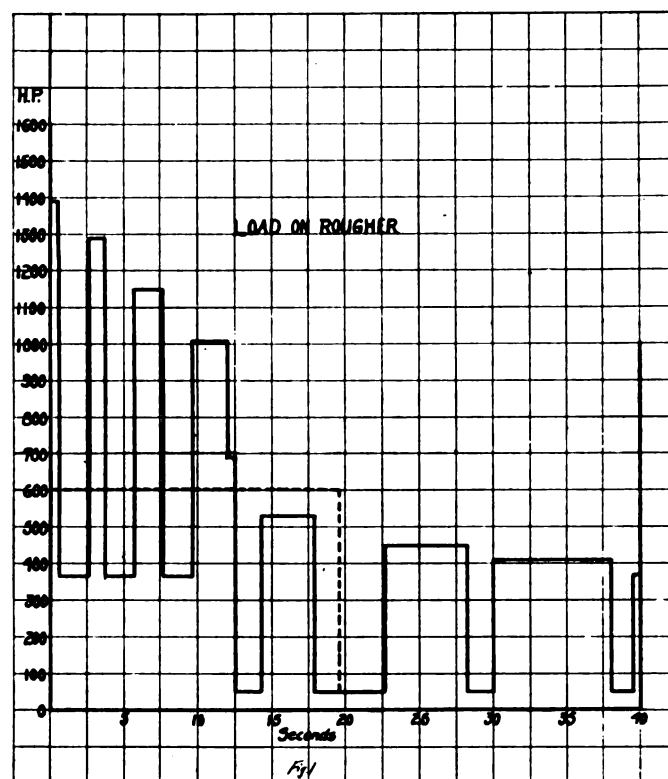


FIG. 1—Graph illustrating the load fluctuation on a 16-in. 2-stand rougher, when rolling 4x4 billets to 1/4-in. rounds.

tion of this energy it must be allowed to slow down under load. On an induction motor drive this is accomplished by means of resistance in the rotor circuit. This resistance may be either of some fixed value, or it may be used in connection with a device which will cause it to vary with load. The most widely used and most satisfactory device of this kind is the liquid slip regulator. Fixed resistance in the rotor circuit simply exaggerates the normal speed torque characteristic of the motor, giving it a greater droop. In order that the speed may decrease the load must increase. Hence the effect of this scheme is to replace a sharp high peak with one which starting at friction value gradually rises to the full value of the peak if this is sustained long enough. At this point equilibrium has been estab-

lished, the flywheel is rotating at constant speed and the motor is carrying the whole load. In case the peak is sustained until the above condition obtains, the flywheel of course is of little benefit.

The liquid slip regulator is made up of moving and stationary electrode immersed in an electrolyte. The moving electrodes are suspended from the arm of a torque motor, which is excited from the primary line through a series transformer. The secondary circuit of the main motor is completed through the liquid between the electrodes. The torque motor arm is balanced by adjustable counter-weights, so that a certain predetermined current in the primary line is necessary before there is any movement of the electrodes, which are normally very close together. If this predetermined

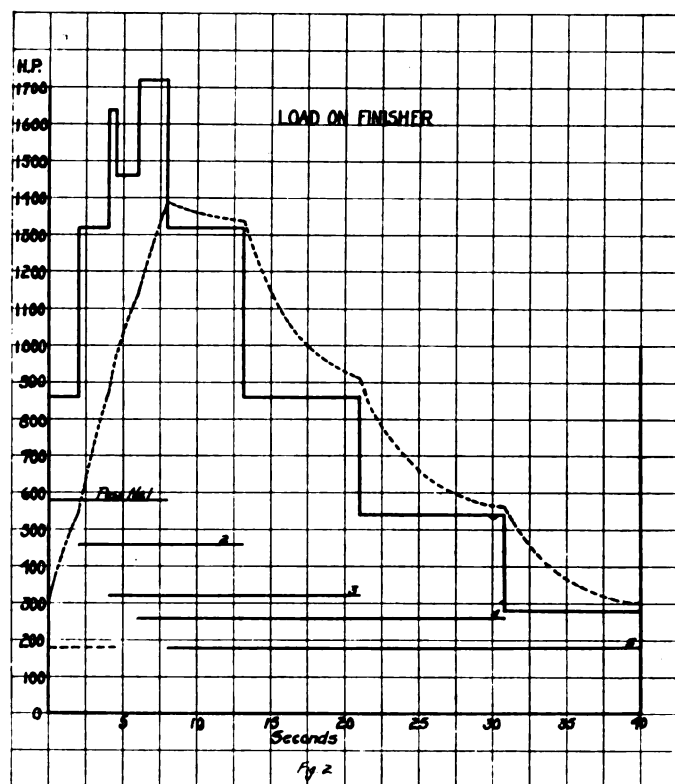


FIG. 2—Graph showing the load fluctuation on the 12-in. 5-stand finishing train.

current is exceeded the torque motor causes the electrodes to separate, introducing additional resistance into the rotor circuit, which causes the motor to slow down and shift part of the peak to the flywheel. As long as the load is higher than the regulator setting, the electrodes continue to separate and the motor to decrease in speed, the flywheel giving up energy at such a rate that it carries the difference. When the peak has passed the regulator still maintains the input at the same value until the rotating parts are again up to speed.

A roughing mill with a load cycle as shown in Fig. 1 is an ideal application for this device. Assume that we apply a 500 hp. motor on this drive with a flywheel and a slip regulator. Assume further that we set the regulator so the load on the motor is limited to 600 hp., which is 20 per cent overload. By referring to the duration of .6 second and requires 1390 hp. This is 790 hp. in excess of the regulator setting. During the first pass therefore, the flywheel must deliver 790 hp. for .6 second, or $790 \times .6 = 475$ hp. seconds of energy.

Between the first and second passes the actual load in the mill is 365 hp., due to the overlapping of Pass No. 8. Since the regulator still maintains the input at 600 hp. there is an excess of $600 - 365 = 235$ hp. which is used in accelerating the flywheel. This condition lasts for two seconds, and 335×2 or 470 hp. seconds are put back into the wheel. Since only 475 hp. seconds were given up during the pass it can be seen that during the first interval practically all the energy taken out was returned to the wheel, or in other words, it had reached full speed again.

Similarly the second pass demands 690 hp. from the wheel for 1.1 seconds or 70 hp. seconds. During the second interval, however, only 470 hp. seconds are returned to it, leaving a deficit of 290, which must be added to the third peak. This procedure is continued, adding the energy taken from the wheel during each pass, and subtracting that returned to it during the interval. At some point in the cycle a maximum will be reached. In the present instance this occurs at the end of the fourth pass when a total flywheel deficit of 2310 hp. seconds is shown. On a roughing mill of this kind a maximum speed drop of 15 per cent. is not objectionable during heavy loads. The flywheel therefore must be of the proper characteristics to be able to give up 2310 hp. seconds of energy in dropping from full speed to 85 per cent of full speed.

The kinetic energy in a moving body is proportional to the square of the speed. At 85 per cent speed the body contains $.85 \times .85$ or 72.2 per cent of the energy at full speed, or the difference between the two is $100 - 72.2 = 27.8$ per cent, 2310 hp. seconds is therefore 27.8 per cent of the total energy in the wheel at full speed. This mill would probably operate at about 100 R.P.M. What is required then, if the wheel is to operate at mill speed, is a total energy content of $2310 \div .278$ or 8000 hp. seconds at 100 R.P.M.

$$8000 \times 550 = 4,400,000 \text{ foot lbs.}$$

Assuming a wheel 18 feet in diameter which at 100 R.P.M. is well within the limits of peripheral speed for cast iron. A well proportioned spoke wheel will have a radius of gyration of approximately $.8 \times$ the radius.

$$.8 \times 9 = 7.2 \text{ feet}$$

The velocity at the radius of gyration is

$$\frac{100 \times 3.14 \times 2 \times 7.2}{60} = 75.5 \text{ feet per second.}$$

Energy for a rotating body = $\frac{1}{2}Mv^2$ where v = velocity at radius of gyration.

$$4,400,000 = \frac{1}{2} \times \frac{W}{32} \times 75.5^2$$

$$W = \frac{4,400,000 \times 2 \times 32}{75.5 \times 75.5} = 49,500 \text{ lbs.}$$

The load diagram over the first half of the cycle would now be as shown in dotted lines in Fig. 1. The last half of the diagram would not be changed since none of the loads reach the setting of the regulator. The R.M.S. value of the new cycle is 490 hp., which is a reduction of 60 hp. below the heating load without a flywheel.

A 500 hp. motor would thus take care of the conditions shown, when used in conjunction with a liquid slip regulator and a cast iron flywheel 18 feet in diam-

eter and weighing 50,000 lbs. This type of drive would keep the peaks from the gear unit as well as the motor, which is an advantage. However, this wheel would necessarily be mounted on separate bearings and the unit would be quite costly. It is quite often found that a considerable saving in first cost can be effected by designing the gear unit to carry the mill peaks, and installing the flywheel effect on the high speed shaft. Due to the fact that the energy of rotation is proportional to the square of angular velocity, only a fraction of the weight need be used. In addition to this, the flywheel effect can be split up into two wheels, and one overhung on each end of the pinion shaft of the gear unit. This does away with the necessity of providing separate bearings.

Assume the motor is to operate on a 60 cycle circuit at 720 rpm. synchronous speed. The gear unit would probably have such a center distance that wheels five feet in diameter could be used. These wheels would have a maximum peripheral speed of 11,300 feet per minute, which is within the limit for cast steel.

The velocity at the radium of gyration would be

$$\frac{720 \times 3.14 \times .8 \times 5}{60} = 151 \text{ feet per second}$$

And the weight required

$$\frac{4,400,000 \times 2 \times 32}{151 \times 151} = 12,350 \text{ lb. or } 6,175 \text{ lb. per wheel.}$$

Due to the fact that the steel is looped throughout the finishing train, the load on this drive, as shown in Fig. 2 builds up to a high value during the first part of the cycle and then falls off gradually. A 1000 hp. motor would be of sufficient continuous capacity to roll this schedule, but it would be subjected to a peak rising to a maximum value of 172 per cent every 40 seconds under normal operation. Unforeseen conditions could easily increase these peaks beyond the overload capacity of the motor.

A flywheel of the proper characteristics will bring this peak down to a more reasonable value. On a cycle of this kind where the maximum loads are not so suddenly impressed or so high in comparison with the average load, it is found that resistance connected permanently in the rotor circuit takes care of the condition satisfactorily.

As stated before in this case the peak is not cut off squarely at a predetermined value, as it is when a slip regulator is used. However, an indication of the size of flywheel required can be obtained by assuming this to be the case. Assume a 1000 hp. motor is to be used and that the flywheel is to carry all overloads above 10 per cent, or 1100 hp. This overload limitation must be placed rather low, since we know that actually the load will rise considerably above it.

The energy in that part of the peak above 1100 hp. can be determined from Fig. 2 as being 3635 hp. seconds. Assume that the resistance in the rotor circuit is such that the speed has decreased 10 per cent when this amount of energy has been given up. Then the energy remaining in the wheel is $.90 \times .90 = 81$ per cent of the total, or 3635 hp. seconds is 19 per cent of the total. The total energy in the wheel at maximum speed is therefore, $3635 \div .19 = 19,000$ hp. seconds. If the mill runs at 200 rpm. a 16 foot cast steel wheel can be used. By the same method as used in the case of the 16-in. mill, it is found that a wheel 16 feet in

diameter and rotating at 200 rpm. must weigh 37,000 lb. in order to possess 19,000 hp. seconds of energy.

By using the formulae developed by Mr. Gasche* the true load curve of the motor under these conditions can now be determined. The application of these formulae requires too much space to be included in this article, but the result is shown in dotted lines in Fig. 2. The overload on the motor has been reduced to 38 per cent, and moreover, this peak, rising gradually as it does, is a very easy load for the motor to carry.

Whether the motor is direct connected or geared to the train, it will probably be found that the best location for this flywheel is on the low speed shaft. A gear unit with the gear shaft rotating at 200 rpm. must necessarily be built with a short center distance in order to keep the pitch line speed within the allowable limit. If flywheels were overhung on the pinion shaft their diameter would be so small in order to clear the gear shaft, that their weight would be excessive.

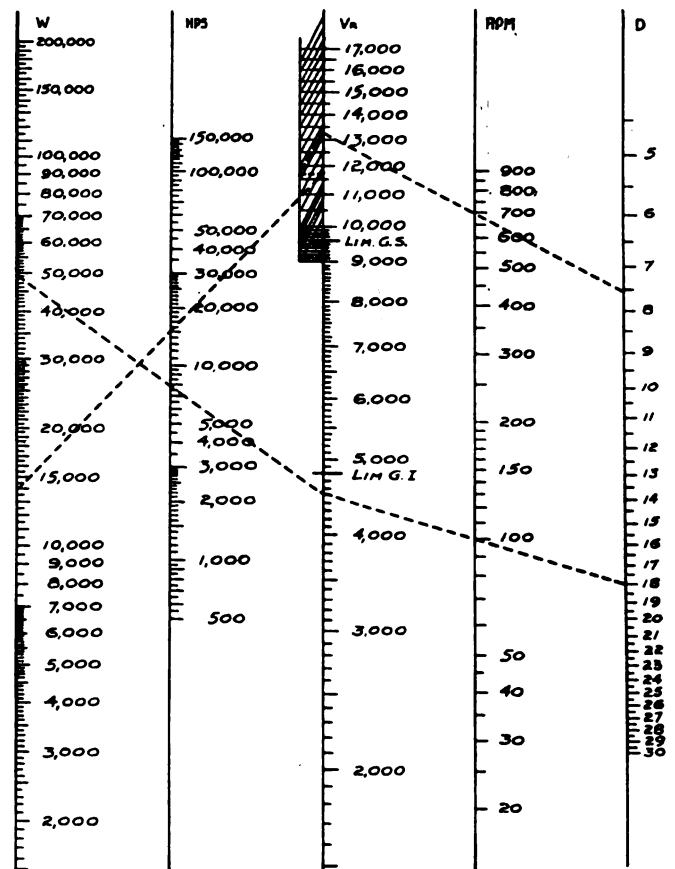


FIG. 3—A chart assembly from which flywheel specifications may be arrived at.

In figuring a mill application it is usually necessary to go through a number of calculations, in order to determine the best location for the flywheel, and the most economical relation between motor capacity and flywheel effect.

By means of the chart shown in Fig. 3 and a straight edge, a close approximation of the weight, energy content, rpm., or diameter of a flywheel can be arrived at if the other three factors are known. Take as an example the 16-in. mill flywheel at slow speed as calculated above. This wheel is to be 18 feet in diameter, and is to possess 8000 hp. seconds of energy at 100 rpm.

*Transactions A. I. E. E. June, 1910.

Lay a straight-edge across 18 in the right hand column and 100 in the second column. The intersection with the middle column is at 4550, which is the speed in feet per minute at the radius of gyration. Lay the straight-edge across this point and 8000 in the hp. seconds column, and the indicated weight in the left hand column is found to be 49,500 lb. which checks the calculated result. The velocities in the middle column are based on cast wheels in which it is assumed the radius of gyration is equal to .8 times the radius. In case peripheral speeds between 12,000 and 23,000 feet per minute are encountered, however, it is necessary to go to built up plate construction. The radius of gyration of wheel of this type is .707 times the radius, which makes correction necessary. This is taken care of by the diagonal lines at the top of the column. Assume a steel plate wheel 7.5 feet in diameter rotating at 700 rpm., and to contain 15,000 hp. seconds. Lay the straight-edge across 7.5 in the diameter column and 700 in the rpm. column. The intersection with the Vr column is at 13,300. This would be the velocity at the radius of gyration were the latter .8 by the radius. To make the correction follow the dotted lines, which determines the correct velocity as being 11,650 feet per minute. Lay the straight-edge across this new reference point and 15,000 in the hp. seconds column, and the required weight is found to be 14,000 lb.

LOCAL STEEL INTERESTS MERGE

A merger has been effected between the Witherow Steel Company and the River Front Land Company, whereby the capital stock of the new Witherow Steel Company has been increased to \$2,800,000 preferred (fully paid and subscribed) and 10,000 shares of common, no par value.

The directors of the new corporation are as follows: W. P. Witherow, G. H. Flinn, Wm. Flinn, J. C. Dilworth, F. C. Stoeltzing and W. P. Snyder, Jr.

The officers are: W. P. Witherow, president; Geo. H. Flinn, vice president; Joseph Dilworth, secretary, and W. G. Watt, treasurer. Otherwise the personnel of the organization remains the same.

It is understood that Dilworth, Porter & Company, of Pittsburgh, have bought an interest in the Witherow Steel Co., and are equipping one of their mills to roll under contract with the Witherow Steel Company the sections developed and patented by the latter company. These additional facilities, together with extensive improvements to the Neville Island plant of Witherow Steel Company, will more than double the capacity of the Witherow Steel Company. The wide demand for automobile parts and other rolled materials produced by this company, has made this increase in facilities necessary.

Samuel M. Vauclain, president of the Baldwin Locomotive Works, has accepted an invitation from Dr. Thomas S. Baker, president of Carnegie Institute of Technology, to address the general assembly of students Wednesday, March 14. Mr. Vauclain should have an interesting message for the students of this remarkable technological institution, as he has worked up through the ranks to his present position. For many years he was superintendent of the Baldwin Works, becoming vice president in 1911, senior vice president in 1917, and president in May, 1919.

WELL KNOWN INVENTOR DIES

The death, on January 24, of David Cochrane, the inventor, designer and first builder of the open feed water heater which bears his name, closes the career of a man whose ideas have resulted in the conservation of millions of tons of coal per annum in the United States and elsewhere. Mr. Cochrane was born in Sawkey, Clackmanmonshire, Scotland, in 1850, and in his early years worked as a pattern-maker on the Clyde. In 1879 he came to the United States, where he entered the employment of Ferris & Miles, but, shortly afterward went with the Harrison Safety Boiler Works then the builders of a sectional cast iron boiler. His open heater, brought out in 1883, was specifically designed to protect boilers from the effects of cold, unpurified feed water and was itself the first to be built of cast iron plates, to avoid corrosion. Mr. Cochrane was also the first to design a successful oil separator, a heater and receiver, and other appliances which have since become standard practice. He was distinguished by great common-sense in engineering matters and had a peculiar capacity for winnowing the wheat from the chaff and for simplifying construction. He was frequently consulted concerning the design of steam plants and his great contribution to steam engineering consisted in focusing attention upon the more efficient utilization of exhaust steam for heating buildings and for heating and purifying water to be used for feeding boilers and for industrial purposes. As early as 1894, he advocated the withdrawal of steam in course of expansion for feed heating and similar purposes, thus anticipating the present day movement to provide all large turbines with bleeder connections.

AN AMERICAN INDUSTRIAL POLICY

Although the loud demand that has been made in England from time to time for a Ministry of Commerce has not produced the desired result, the United States seems to have gone on something of the line intended by the advocates of our Ministry of Commerce, and with great success. The United States Department of Commerce, according to reports coming over, is working hand in hand with the industries in America to a very good purpose, and there has been introduced what is a new slogan in the form of the word "simplification" in industry. In a sense this is little more than standardization, and much of the work being done in this direction in the States has been in hand in this country for several years. But the fact is that by co-operation between the State and the industries in America a position has been reached which, without in any way involving State assistance financially or in the matter of control, has enabled a great deal more progress to be made than will ever be possible here under our present conditions. The new idea does not only concern questions affecting trade overseas, but of manufacture generally, the fundamental idea being to reduce the number of processes involved in the manufacture and selling of goods generally. The mechanical-engineering industry is specially concerned, and the claim is already made that where the simplification idea has been attempted there have been lower prices and better business. It does not only concern methods of manufacture, but methods right through to the consumer, and includes distribution, which deserves a great deal more attention than it often receives here.

Safety For The Small Plants

Many Small Plants Are Turning in Monthly Safety Records, Surpassing the Large Plants—No Extensive Personnel Need Be Added to Attain Results.

By FRANK H. ROWE*

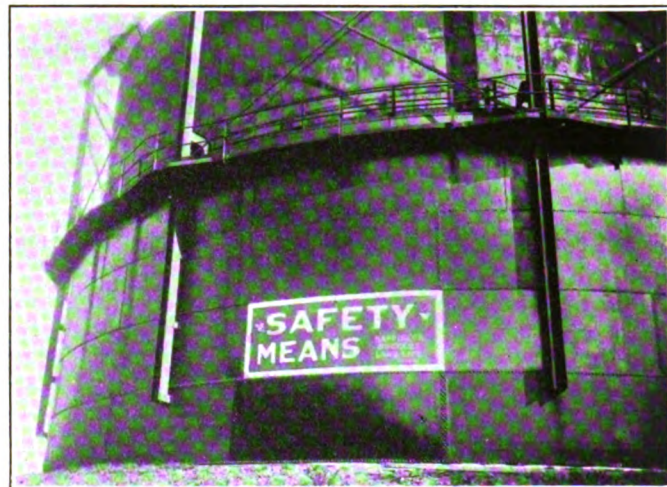
NO doubt many superintendents and managers of small plants have many times wished that it were possible to have some sort of an accident prevention scheme in their plants. The small number of employees does not merit the employment of someone to carry on this kind of work, even though the need of it is easily seen. They have been reading articles in the current trade journals about the need of organized safety to combat the increasing accident rate and other articles pertaining to other forms of safety. I do not remember of having read in any of these articles just how this is to be done, and it will be my purpose in this article to give an outline of how any plant, no matter how small, can have a definite accident prevention program with a very small outlay of money and no addition to the present working force. By a small plant I mean a plant that employs from 100 to 500 employees.

Have you ever stopped to think that some of the best records in reducing accidents have been made on small plants? This has been done in plants that do not employ someone to look after safety work. I have in mind a certain company that reported a 35 per cent reduction in their accident rate over the previous year without the aid of a safety director or inspector. This plant employs on the average 750 employees and their work is of a hazardous nature.

We will take for granted the fact that you believe in safety and its principles and that the only thing that keeps you from taking up this kind of work is the fact that you are afraid that your organization cannot afford to spend the money necessary to carry it on. We will not take for granted though the fact that you know that real safety is about 25 per cent mechanical guarding and 75 per cent educational work. We prefer to tell you this for a fact gleaned from our own experience in safety work. We will admit though that this ratio has seemed somewhat out at times. Many times we have felt like it was about 5 per cent mechanical guarding and 95 per cent educational work. Now, it doesn't make any difference whether or not you believe in safety work, the fact is this—you are now and have been for some time doing 25 per cent of safety work that we call mechanical guarding. You probably doubt this statement; nevertheless it's a fact. The reason that you have been doing it is the fact that the State Industrial Commission has forced you to do it. Have you not done work about your plant that the state inspectors have ordered you to do? Have you not built certain guards that seemed necessary? This part of safety work that you have been unconsciously doing is the most expensive part of safety work or a safety program. The other 75 per cent will not cost you near as much money and will produce greater results than the former. Both are essential if you are to get results in accident reduction. You have wondered no doubt why you still had accidents after

you erected the guards that you thought necessary. For instance, a man gets a small cut on his hand and pays no attention to it and it later develops into a bad case of infection which results in the loss of several weeks time for that employee. This isn't the fault of guards or the lack of them, it's merely the lack of the other 75 per cent of safety work known as educational work.

What is the first thing that we want to do in starting this educational work? Being of an educational nature, it must either be told to the employee by word of mouth or through the means of the printed word. We select the latter unless the plant employs less than 100 men because the first way would take too much time to put it across, and, incidentally, costs too much. To make a long story short, we will erect a bulletin board some place where all of your employees can read the bulletins that we will post on it. Not wishing to get away from the subject in hand, we venture the assertion that you are thinking of one of those fancy bulletin boards with glass doors and the like with a fancy safety motto scrolled over the top of it. Alongside of this board you



SAFETY

An effective method of safety sign used at Portsmouth. Curves showing cost of pipe joints.

probably placed about \$25 or \$50 as the cost of same. Immediately you say that you cannot afford it, and if your plant is small you are not able to erect such a board. We do not have any such board in mind. What we are thinking about is three or four pine boards nailed together with a small molding around them and planed smooth, with about two coats of lamp black and turpentine applied to the smooth surface. All told it would cost about three or four dollars and anyone with a little carpenter experience can build it. Of course, the fancy bulletin board would look the best and might be the

*Portsmouth By-Product Company, Portsmouth, Ohio.

best, but the blackboard will do just as much work and do it just as well.

Now that we have the bulletin board, what are we going to do with it? Where are we going to get bulletins to put on? Just as a sample you can post one like the following one:

**YOU MUST BE CAREFUL
DURING**

D E C E M B E R—1922

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

*To avoid Accidents, so that you
can spend Christmas with your
Family and not in the Hospital*

To make this bulletin all you need is a piece of school crayon and the sheet from one of your calendars. That's one bulletin, but where are the rest coming from? Well, you figured that a bulletin board would cost you \$25 at least, didn't you? You had just about made up your mind to invest \$25 in one of these bulletin boards, and now that you got one for \$5 you can afford to invest the other \$20 in something else. Suppose we just send in our subscription to the National Safety Council, Chicago, Ill., which will cost us \$20 per year if you employ less than 150 employees and \$40 if you have from 150 to 600 men. For this \$20 we get a monthly magazine devoted to safety and its many phases and the elimination of accident hazards. In addition to this we also get 36 real live safety bulletins with the privilege of ordering 25 more if we want them. This means that if we order the 25 extra bulletins every month that we will receive 732 bulletins for one year. In addition to this we have the privilege of asking for assistance in the elimination of any special hazard that exists in our plant. If you pay \$40 you get twice as many bulletins. The magazine itself will provide plenty of material for your safety committee and will keep them interested in safety work.

The organization of a safety committee is something that we do not want to forget. You really ought to have two committees, one composed of workmen alone and the other one composed of the superintendent, master mechanic and one or two other foremen. The workmen's committee should consist of from three to five members. Minutes should be kept of the meetings. Meetings should be at least monthly. They should be short and snappy. If you drag them out over half an hour they get stale and the interest that you have created is dampened. Appoint your members of this committee and call them together and in a short talk explain to them that you want their assistance in stopping lost time accidents and breaking up bad practices that cause them. Ask them to bring in their suggestions, telling them that each suggestion will receive your personal attention. If one of them should happen to turn in a very good suggestion the next time you meet him on the job don't forget to mention it to him, thanking him at the same time. At these committee meetings take up and discuss accidents that have happened at your plant and other plants in the vicinity. If a serious accident happens at another plant and an account of it is published

in a local paper, clip out the account and post it on your bulletin board with a suggestion that your men watch their step. There are many things that you will be able to do with safety committees after you once get them organized. The main thing is *get them organized and functioning*.

Do you have any means of giving first aid on the job? Do you hold any particular person responsible for this work? It doesn't make any difference how small your plant is, you should have some form of first aid to administer to your employees who suffer minor injuries. If you take care of your minor injuries you will prevent infections, thus stopping lots of nasty accidents. Put out a rule that all minor accidents must be reported to their foreman and he in turn will send them to the first aid to have it taken care of. Maybe you have some one in the office or a watchman who could render first aid on minor accidents. If so, make him responsible for these cases and let him make out a report and hand it to you. A suitable report is shown with this article that will answer the purpose or you can change it to suit your plant or conditions. Keep them on file and they will help you to check upon what your accidents really cost.

If you should care to invest \$15 in a permanent safety bulletin the picture of one erected at our plant might give you an idea to follow out. Put it some place where your men can see it as they come to work. It creates a good impression and serves as a daily reminder to those who might otherwise take chances.

These are a few of the things that you can do with a small outlay of money, say \$100 at the most, and in most small plants it can be done for as little as \$40. Surely this is small when you compare it with the cost of one bad accident. A bad infection case resulting from the neglect of a small injury will sometimes cost more than that. For the first three or four months you should play up and preach the reporting of small injuries to your first aid. Do this through your safety committees and foremen. Make your foremen understand that you mean what you say when you want all minor injuries reported. You no doubt may have to put this thing over all by yourself, but once you get it started you will have others in your organization willing to do their part and assist you.

Now, to sum it all up: First, erect a cheap bulletin board if you can't afford a fancy one; second, get a supply of bulletins by joining the National Safety Council; third, organize your safety committees; fourth, provide some means to take care of minor injuries; fifth and last, but most important, convince your men that you are behind it to the finish. Say to them that it is going to stick, not because it is a pet idea of yours, but because it will save you money and increase the happiness of your men and their families. What more could you ask for a small investment?

AUSTRIAN IRON OUTPUT DECLINING

The Austrian market for iron and steel is at present a consumers' market, according to a cable to the Department of Commerce from Trade Commissioner W. F. Upson. Wholesale dealers are engaged in a price cutting campaign in which replacement costs receive little consideration. The price on inland pig iron has declined to \$24 per metric ton at the end of January. The export trade has been greatly hampered by the foreign exchange regulations in neighboring countries and by high customs duties, particularly in Czecho Slovakia.

The Wire Drawing Die

A Historical Description of the Simplest and Most Effective, Yet Least Known, Metal Working Tool—The Art Flourished a Thousand Years Ago.

By K. B. LEWIS*

AMONG metal working tools the wire drawing die easily ranks first in point of simplicity and effectiveness. It delivers a product of uniform size and section in practically unlimited lengths and in sizes so small as to be absolutely impossible of attainment through the use of any other tool. It hardens and polishes the surface of its product and raises its tensile strength. In combination with heat treatment it gives to steel a combination of strength and toughness vastly greater than can be achieved by any other tool or process. It acts as a continuous and automatic testing machine, detecting flaws of surface or interior and announcing them in such terms as to command instant attention. Finally it performs all these functions simultaneously and with the aid of only the simplest application of force—a straight pull.

Was wire drawing an invention in the sense that it was conceived and reduced to practice by a single brain, or was it a gradual development to which many minds contributed over a long period of time? We cannot answer this question definitely nor can we assign to its beginning a date or even an epoch. We can say with assurance that at a certain period in the middle ages wire was made by drawing through dies and that the process was well enough known to be merely mentioned without comment in a manuscript devoted to detailed description of novel methods of metal working. We can say that at an earlier period wire drawing certainly was not practiced by the artisans of the most advanced culture then in existence; that wire was made in quantities even in the finer gauges by the clumsy, costly process of shearing, hammering and soldering. Between these two periods, however, there stretches unbridged a gap of one thousand years.

The Fifteenth Century.

In the fifteenth century wire drawing was understood and practiced in the leading European countries. The town records of Coventry, England, of the year 1430 show the art to have been in such a flourishing state that the guild of wire workers asked and were granted the privilege of furnishing and maintaining a canopy over the altar of the church of Saint Michael. Other passages from the Coventry records give the names of the members of the guild, listing them as rod makers, annealers, coarse wire drawers, fine wire drawers, etc., in such terms as to present a very fair picture of the art as we practice it today. In Italy, Leonardo da Vinci, always thinking not years but centuries ahead of his time, was sketching machines with sectional dies for the drawing of special shapes. In Germany, Rudolph of Nuremberg, "skilled in metals," was developing in secret the process of drawing wire "by labor of wheels." In Paris, even in the thirteenth century, there were listed in the city records no less than seven wire drawing establishments, and

a code of rules governing the employment of apprentices in such plants.

The Tenth Century.

Theophilus, writing at a still earlier period, mentions wire drawing dies as tools to be found in any well equipped metal working plant. Processes which he apparently regards as novel he describes in detail, but wire

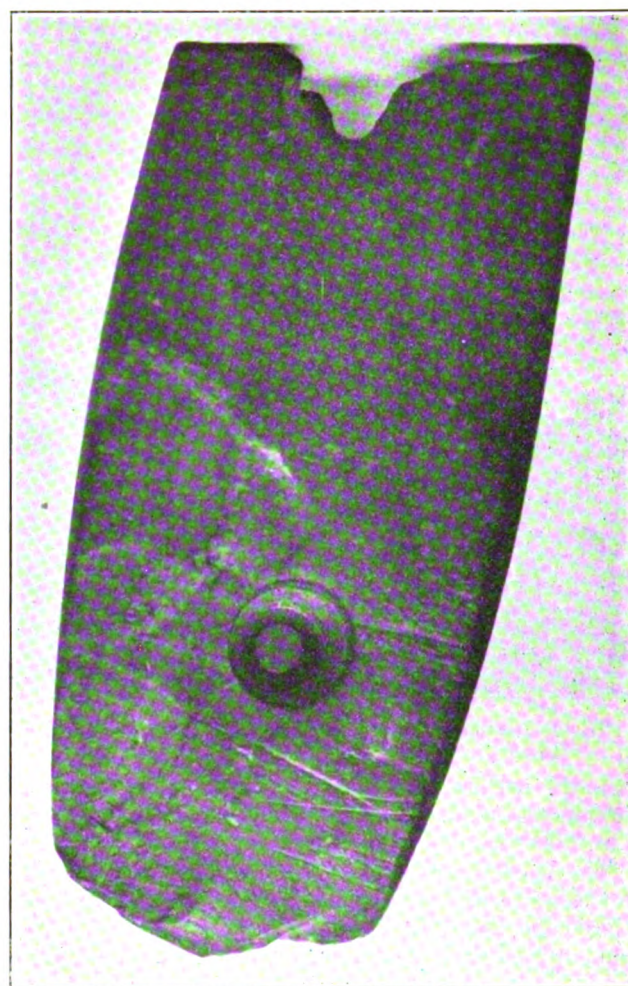


FIG. 1—Stone with holes ground in center, probably used by very primitive wire drawers.

drawing and dies he mentions without comment. There may be significance in the fact that he has no specific word for the die, but refers to it as "the plate pierced with holes through which wires are drawn (fila trahantur)." This may mean that the die was well enough known to need no further description, but yet new enough to have had no specific name attached to it. On the other hand, Theophilus wrote in Latin, as was the

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custom of the time, whereas the artisans undoubtedly used the local dialect, and it is entirely possible that a word existed in the local dialect which had no equivalent in the dead language of polite society and letters.

This reference to the die seems to be the earliest known. Unfortunately Theophilus did not date his manuscript and authorities differ as to the time and place of its origin. The internal evidence seems to place it between the years 700 and 1000 A.D.

Egypt and Rome.

We have worked back from the year 1430 when iron wire was certainly drawn in dies to about the year 1000

Pliny, in his "Natural History," covered the arts and sciences as with a blanket, but on wire drawing he is dumb. In the time of the Caesars there is said to have been a lively trade between the Roman provinces of the East African coast and the Arabs, and through them with Persia, India and China. Juba, son of the conquered king of that region, and himself provincial governor under Rome, was active in promoting this traffic and wrote voluminously on all its aspects. Fragments of his reports are quoted by writers whose works might better have been spared, but of Juba's volumes not one has been found. While, therefore, it is barely possible that wire drawing was practiced in the Eastern countries, it is not at all probable, for in such a case we might reasonably expect specimens of the superior product to have reached Rome, and to have been preserved.

The Die as an Invention.

Let us assume for the moment that the wire drawing die was an invention in the strict sense of the word—that it was the product of a definite time and place. We will assume the place to have been Europe, the time about 1000 A.D., these being the circumstances of our earliest reference. Inventions are made sometimes as a form of self-expression on the part of the inventor, but more commonly in response to a specific demand, the satisfaction of which implies a reward to the inventor. There existed at that time and place two conditions likely to create such a demand. One was altar decoration, the other chain armor.

A notable revival in piety took place throughout Europe at this time, finding expression largely in the building and adornment of cathedrals. This revival arose chiefly from feelings of relief and gratitude to God that He had not fulfilled the dismal prophecies of the times by destroying the world at the end of 1,000 years of Christ's reign. Among the altar furnishing articles of gold and silver wire and of chains and embroideries made from such wire were very prominent, as may be judged from the writings of Theophilus. Chain armor also began to come into use at this time. All Europe was boiling with small wars between neighboring barons, and the great crusades against the pagans who defiled with their presence the holy places of Palestine were already afoot. Hand-to-hand fighting with axe, sword and spear made body armor a vital need. This was very likely the first steady demand for considerable quantities of iron wire. Whether or not chain armor was made from drawn wire we may never know. Specimens known to be of the period prior to 1100 A.D. are too badly corroded for careful examination. In later and better preserved specimens, the links have been deformed by flattening and twisting, and the finished fabric case-hardened, so there remains no sure way to identify the process.

Of these two possible stimulants to invention, the weight of evidence favors the former. All signs indicate that the soft metals were drawn before iron was thought of as a possible product of the die. Such references as are made by Theophilus to wire drawing are in connection with the soft metals only. The Paris records, dated 1270 A.D., speak of wire drawing in such terms as to make it very doubtful whether any but the non-ferrous metals were drawn. Biringucci, describing wire drawing as practiced in Italy in 1540 says in conclusion, "I have heard that iron also can be drawn in the same way if it be frequently softened by fire." It seems then that so far as facts and reasonably safe inferences go, the die was in common use for the soft metals many years before iron wire was drawn.



FIG. 2—An early use of crude metal wire drawing block.

when the earliest known reference to a die or to wire drawing was made. Let us now work up toward the die from the other end of the calendar.

The earliest civilization of which we have adequate knowledge is that of Egypt. There are large and interesting collections of Egyptian jewelry of which ornaments of gold wire form a large part. The writer has had the privilege of examining under the microscope such articles as coronets, chains, bracelets and woven wire girdles, involving the use of gold wire in sizes from $\frac{1}{8}$ in. to $\frac{1}{100}$ in. diameter. The wire was, beyond the shadow of a doubt, made from short strips clipped from beaten plates, twisted, hammered and then soldered together. Greek and Roman jewelry tell the same story and bring wire making to the beginning of the Christian era still dependent upon the hammer and file.

Herodotus, traveling widely, observing with an accuracy for which he has never been given sufficient credit, reporting faithfully not only what he saw but what he heard, has never a word to say about wire drawing.

The Die as a Slow Development.

Theophilus, describing the making of gold or silver chains from wire, recommends that they be polished and brought to uniform size by pulling them through a hole in a piece of wood. It requires no great flight of fancy to picture one of the early wire makers pulling a strand of hammered gold wire through such a hole to polish out the hammer and file marks. Gold wire is very easily worked. If the wood were hard and the hole the least bit small and the wire slightly pointed the operator might find himself drawing wire involuntarily. Upon realizing the situation he may be supposed to have searched for still harder wood and then experimented with iron or possibly stone dies, gradually coming to see the process in its true light as primarily a reducing rather than a polishing operation.

The rounding and polishing of strips by drawing through a tapering hole in a die of harder material was probably a familiar operation among primitive people centuries before metals were drawn. Among the relics of the "lake dwellers" of Europe are pierced stones which have been dismissed by archaeologists as "articles of unknown use." The writer has a similar stone pierced with a round tapering hole, slightly relieved on one side of the stone and flaring widely on the other—a perfect wire drawing die, but with a rather short bearing. This stone is an Indian relic found with a variety of Indian tools in the town of Spencer, Mass., some years ago. It is thought to have been used for the rounding up of raw-hide strips for various domestic uses. The bearing shows the characteristic glaze found on stone tools used by the Indians for scraping hides.

Iron Wire.

The earliest specific reference to iron wire as a drawn product is in connection with the work of Rudolph of Nuremburg. From the records describing his plant it appears that the interest of the observer was chiefly in the "great cylinders with many teeth," which, driven from a water wheel, forced other cylinders into motion and finally "forced the iron rods through the small holes and by pulling, made them longer." Whether the drawing process escaped further description merely because it was overshadowed in interest by the first gear reduction he had seen or whether because the die was a tool already known, it is difficult to decide. The writer inclines to the belief that Rudolph, having harnessed water power and taken control, through gear reduction, of forces greater than ordinary, was the first to apply to iron a process long known as a satisfactory means of reducing the soft metals to wire.

It is a fact that wire makers, previously listed in the town books of Nuremburg as "wire smiths," began about 1350 to appear under the names of "wire drawers" and "wire millers." The first of these two new titles implies dies, the second, water power. It is no less a fact that in 1370 Nuremburg had easy command of the needle trade of Europe and that fact seems consistent with the theory that she enjoyed some outstanding advantage over her rivals, such as a supply of die-drawn iron wire.

On the other hand Theophilus makes one specific reference to "iron wire" in such connection as to raise a doubt whether any but drawn wire could have been meant. Describing the making of large copper tubes for organ pipes he directs that the copper sheet, cut to pattern, be wrapped around an iron mandrel in such a way that the edges, previously roughened with a file and tinned, will overlap evenly, and that it be then wrapped

around with "iron wire" in a long spiral path from end to end of the mandrel. After the soldering has been completed the whole job is swung in a lathe and revolved by pulling on one end of the wire, while the tube is polished. "Iron wire medium coarse" is specified. It would seem probable that to do this job neatly, and to uncoil readily in the lathe, the wire would have to be of a size very difficult to produce in such lengths otherwise than by drawing. The hot working and welding together of bits of iron in such small sizes would be extremely difficult. The words "medium coarse" surely imply the existence of iron wire of a gauge still finer than this job requires. With a half dozen more words, Theophilus could have resolved all our doubts.

Summary.

A careful examination of existing records, references and specimens, brings out the following facts and reasonably safe inferences:

1. Before the Christian era wire was employed solely for decorative purposes and was made only of the softest metals by the process of slitting, hammering and filing.
2. The use of round holes pierced in relatively hard material for rounding and polishing strips of soft material was common among primitive peoples.
3. At the time of Theophilus (approximately 1000 A.D.) this use of tapered holes in hard plates had developed into the actual wire drawing of soft metals, but probably not of iron.
4. In the period between 1300 and 1350 the wire drawing process was extended to cover iron.
5. In 1430 iron wire was made substantially as it is made today.

DR. BAKER SUCCEEDS DR. HAMERSCHLAG

The recent election of Dr. Thomas Stockham Baker to the presidency of Carnegie Institute of Technology at Pittsburgh calls to mind the remarkable growth of this college since its establishment 20 years ago. Founded in 1903 by Andrew Carnegie as an industrial school for young men of small means it has since become one of the largest technological institutions in the world, rated at the highest standard.

Its enrollment this year is about 4,200 students representing 26 foreign countries, and 41 states, in addition to Alaska and the District of Columbia. The faculty numbers nearly 400.

Dr. Baker, who succeeds Dr. A. A. Hamerschlag the president for nearly 20 years, has been secretary of Carnegie Tech since March, 1919, and acting president since June, 1922. He is widely known in the East as an educator, speaker, and contributor to literature. He was born March 23, 1871, in Aberdeen, Hartford County Maryland, and is a graduate of Johns Hopkins University with degree of A. B. in 1891, and Ph.D. in 1895. From 1895 to 1900 he was associate in German language and literature at Johns Hopkins, and from 1900 to 1908 he occupied the chair as professor of German. In 1909, he became director of the Jacob Tome Institute, at Port Deposit, Md., where he remained for 10 years, leaving to accept the secretaryship at Carnegie Institute of Technology.

Dr. Baker is extremely popular with the faculty and students, and his election to president has been heartily endorsed at the Institute and throughout the District.

—Excerpt from United Effort.

Observations on the Use of Coke-Breeze as Auxiliary Fuel in Steel Plants*

Higher Ash-Content, Higher Excess-Air Usually Result in Lower Efficiencies Than With Coal—Lower Over-Ratings Are to Be Expected.

By WALTER N. FLANAGAN†

THERE are many blast furnace and steel plants, which for various reasons, are not equipped with stokers designed especially for burning coke breeze. Quite often the supply of coke breeze is too small or too irregular to pay for the installation of special fuel burning equipment.

Some of the breeze can be used on the blast furnace runners and ladles and some at the pit furnaces.

It is now recognized that the surplus can be burned on almost any stoker or grate provided with forced draft if the slope of the grate surface is not excessive.

On an underfeed stoker of about 20 deg. slope there is almost no avalanching or running of the fuel even when straight breeze is burned.

However, the same efficiency must not be expected with coke breeze or high percentage mixtures of breeze and coal as is obtained with straight coal. In the first place, the breeze contains at least twice as much ash as reasonably good steam coal. This means that for equally complete combustion the ash loss is twice as great with coke breeze. In most cases the stack temperature will be higher with coke breeze than with coal in spite of a lower temperature fuel bed. This is due mainly to less heat absorption by radiation.

Usually it is not possible to secure as uniform a fuel bed with coke breeze or mixtures, thus the excess air loss is higher as well as the combustible in the ash. The fuel bed must generally be carried thinner than with coal to reduce the forced draft pressure required and thus decrease the tendency to blow holes in the fire.

With straight coke breeze on underfeed stokers only about half the maximum and half the continuous rating can be reached that are obtained with good coal. However, this is done without arches or other auxiliary equipment.

There is usually a dead space of about 6 inches or more from the front wall before ignition is well started.

When operating with large percentages of breeze or with straight breeze it is necessary to carry a fairly constant and uniform load as during shutdowns the fire becomes dead and requires excessive manipulating to bring it back into shape. High air pressure (above 3 inches of water) tends to tear holes in the fire and blow an excessive amount of fines over into the setting.

With mixtures of 25 per cent to 40 per cent coke breeze and 75 per cent to 60 per cent coal, even with a ratio of heating surface to grate surface of over 50, peak loads up to 300 per cent rating for 15 minutes or longer

and continuous loads of 200 per cent have been carried.

The fires must be watched for uniformity of fuel bed since even after careful mixing the coarser coke will separate from the fine breeze or fine slack when running into hoppers, etc.

Coke breeze varies widely in its characteristics even with a given analysis, due principally to the percentage of fines. With hand firing or on underfeed stokers whether burned straight or mixed with coal the fine breeze or dust causes practically all of the trouble experienced.

Breeze which has been run over a 3/16-in. to 3/8-in. mesh screen to remove the dust can be burned with but little more trouble than coal. As the percentage under 1/4-in. screen increases the fuel bed tends to form into large cakes which not only tends to increase the ash loss, but also the excess air loss and requires more labor and supervision.

An average of some samples shows little difference between the fine and coarse particles of breeze except a slight increase in sulphur and ash is shown:

	Through 1½" Round and over ¾" square mesh.	Through ¾" square mesh.
Volatile matter ...	5.63	5.07
Fixed carbon	75.23	74.50
Ash	19.14	20.43
Sulphur	.84	1.23

This, however, does not appear to be sufficient to cause the wide variation on the grates in spite of the fact that the ash from the fines generally contain more iron and has a lower fusing point.

Analyses of some samples of breeze show a greater difference between the fines and coarse, the fines having higher volatile matter, higher ash, higher sulphur and lower fusing point of ash.

However, regardless of analysis the action of the fines appears to be the same and causes the same troubles whether burned straight or mixed with coal.

Since part of the breeze can be used in blast furnace runners and ladle and in the pit furnaces it pays to screen the breeze and use the fines for the above purposes where they have been found to serve better than the coarse the coarse breeze being burned under the coke boilers. The screens can be readily incorporated in the coke breeze handling arrangement thus saving rehandling.

By so doing, without penalizing the blast furnace or the pit furnaces, better boiler operation can be secured with less labor. The screens can be of such mesh that the fines will be just about sufficient to meet the demand

The removal of at least part of the fines is also advantageous with stokers designed especially for burning coke breeze.

*Delivered before the A. I. & S. E. E., Pittsburgh.

†Fuel Engineer, Carnegie Steel Company, Ohio Works, Youngstown, Ohio.

Methods of Ash Handling*

A Subject of Increasing Importance, Due to Labor Shortage and Costs—Many Varieties of Design and Equipment Now in Use.

By JOHN HUNTER† and ALFRED COTTON‡

ASH handling is just as important as coal handling. It was originally accomplished entirely by hand, but with the growth of the size of boiler plants it is now either partly or entirely mechanical. There are three general methods of conveyance in use: air, water, and purely mechanical.

The great development of the central electric generating station has compelled operating engineers to give much attention and thought to ash handling. It is only a few years since boilers of 600 hp. were considered large, while today 2,000-hp. units are not at all uncommon and some 3,000-hp. boilers are in use. Further-

Various methods of handling ash are described and illustrated in this paper, the greater part of which deals with stationary practice, beginning with rudimentary and progressing to the most modern installations, of which schematic and actual examples are given.

Methods of removing ashes from basement boiler rooms are followed by a discussion of the design, construction, and capacity of hopper ashpits, including their doors and water seals. Systems of mechanical conveyance and elevation are described, comprising ash cars, skip hoists and bucket conveyors. Fluid conveyance, as represented by water sluicing and steam-jet conveyors, is discussed in general, and typical examples of both are illustrated and described in detail. Particulars of ash bunkers and settling basins are also given.

more, while boilers were usually operated at about their rating of 10 sq. ft. of heating surface to the boiler horsepower, they are now commonly operated at twice their nominal rating; and in the larger central stations it is common practice to run them for short intervals at three or even four times their rating. The bearing of this development on ash handling may be strikingly seen when we remember that a 250-hp. boiler running at rating and burning coal with 15 per cent of ash would make 150 lbs. of ash per hour; while each 2,000-hp. unit at 200 per cent of rating makes well over a ton of ash per hour.

While the complete paper deals with both stationary and marine practice, the present abstract is limited to the former, although definite progress in ash handling was first made on shipboard.

*Contributed by the Materials Handling Division and presented at the Annual Meeting, New York, December 4-7, 1922, of the American Society of Mechanical Engineers. Abridged.

†Chief Engineer, Heine Boiler Company, St. Louis, Mo.

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Except that there are several standardized types of conveyors, classification of methods of ash handling is not convenient and would serve no useful purpose. Therefore no real classification will be attempted, but

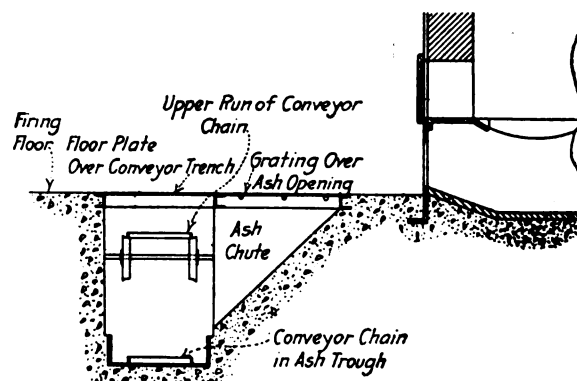


FIG. 1—Chain and cross-bar conveyor.

several different schemes and installations will be described.

The most rudimentary method is that in which the ashes are hoed out of the fire doors and ashpits on the firing floor and shoveled into wheelbarrows. In some

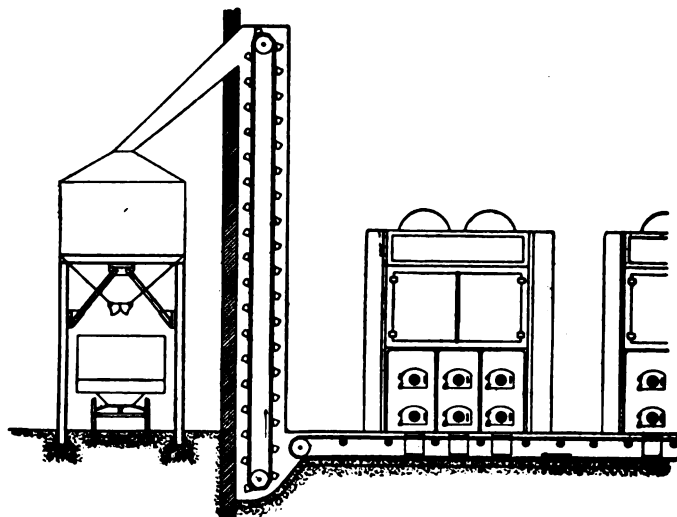


FIG. 2—Chain and cross-bar conveyor with bucket elevator and ash bunker.

cases the ashes are shoveled into industrial railway cars, which are then pushed to the dumping point. The wheelbarrow can be replaced by either a mechanical or air conveyor.

Fig. 1 is a cross-section of a block-chain conveyor running in a trench under the firing floor. The ashes are hoed on to the grating through which they fall down the chute to the bottom of the trench. They are then drawn

along by the chain, discharging into a bucket elevator as illustrated in Fig. 2, or on to an inclined chain conveyor carrying the ash into an elevated storage hopper.

Where there is a plentiful supply of water, a flume may be carried along under the firing floor and the ashes raked into it through openings.

The problem is more complicated when the boiler room is considerably below the ground level, as in office buildings, hotels, etc. Whatever the final disposition may

motor is conveyed by a flexible cord from a socket in the plant and snapped to the motor when the ash truck arrives. Opening the sidewalk cover, the hook is dropped and the first ash can attached, quickly hoisted to the davit head, the davit swung around and the ash can dumped into the wagon, and then returned to the basement. The whole operation is completed in a few minutes.

In some instances the air conveyor (so-called steam-jet conveyor) has been used very advantageously in hos-

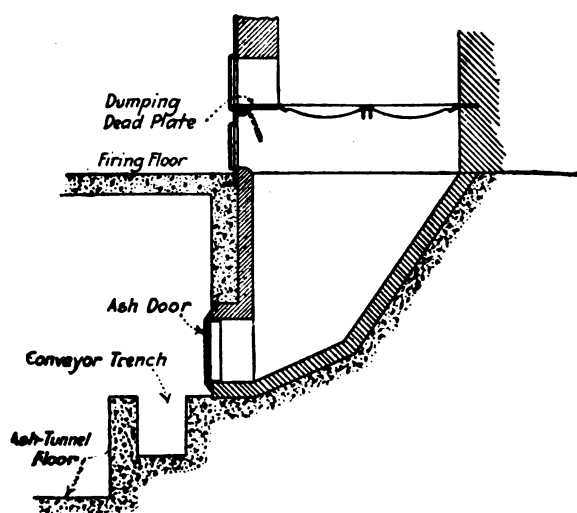


FIG. 3—Hopper ashpit for hand-fired furnace

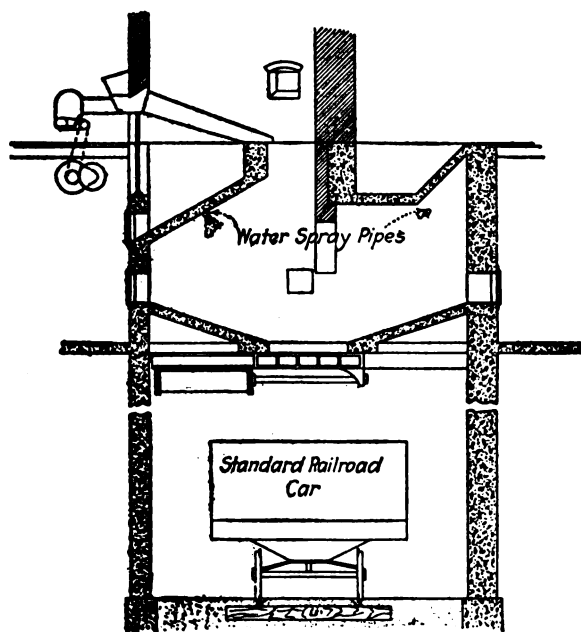


FIG. 4—Large capacity hopper ashpit.

be, the ashes are invariably removed from the vicinity in motor or horse-drawn trucks. Here, the important consideration is principally that of hoisting the ashes from the boiler room to the street. In the isolated heating plants of the Union Electric Light & Power Company in St. Louis, the ash trucks are equipped with a davit just like a regular boat davit on shipboard. A small winch with a 4-in. barrel geared to a $\frac{1}{4}$ -hp. electric motor is mounted at the side of the truck. A $\frac{3}{16}$ -in. steel wire rope is attached and wound on the winch barrel, and passed through a pulley block hanging from the head of the davit with a hook at the free end. Current for the

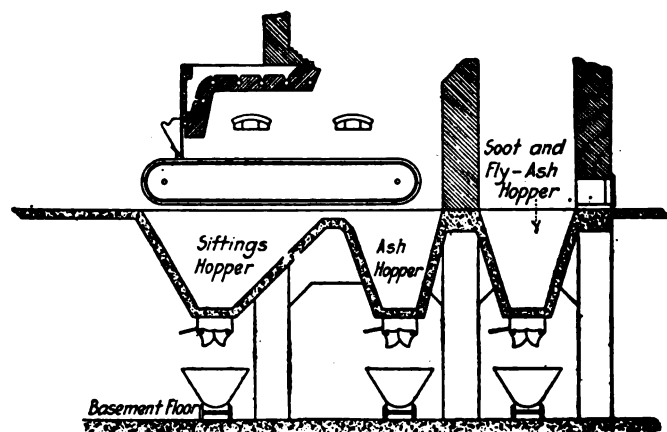


FIG. 5—Hopper for ashes, coal siftings, and soot.

pitals, hotels, and office buildings in crowded parts of cities, but it is not always applicable.

Another method is the "post box" elevator. The ashes are stored in the boiler room until the arrival of the ash truck. The elevator, which is of the bucket type, has a telescopic housing which is pushed up through the sidewalk opening and the chute extended to discharge into the truck.

The first operation where labor can obviously be saved

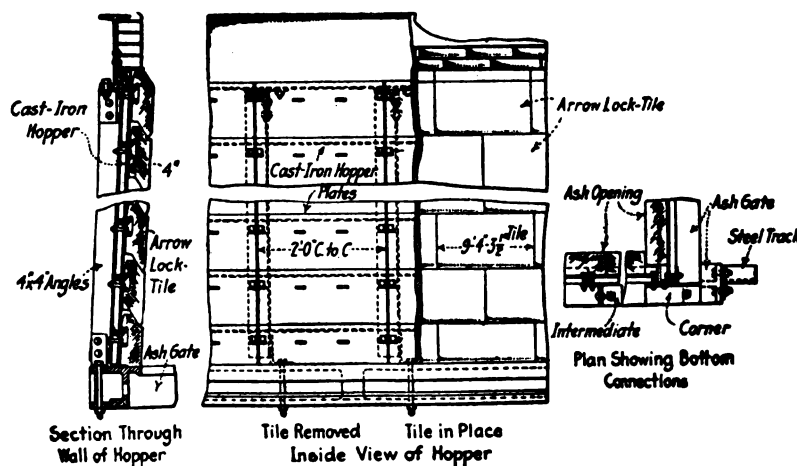


FIG. 6—Baker-Dunbar-Allen ashpit.

is in avoiding hoeing and shoveling ashes at the outset. This leads naturally to a consideration of the hopper ashpit.

Hopper Ashpits.

The hopper ashpit is regular practice in the modern plant. Its size and general design will depend primarily upon the manner in which the ashes flow into it, the method of removal, and also upon the system of draft. The design begins at the top to suit the stoker.

In hand-fired, forced-draft anthracite plants the top of the hopper will conform to the whole grate area. With

stationary grates fine ash is falling constantly over the whole area. As the fires are hand-cleaned, a dumping deadplate will keep the ash away from the firing floor and allow it to fall directly into the hopper, the forced draft being temporarily shut off. With dumping grates the ash will also fall from most of the grate surface. The discharge door must be airtight to avoid increasing the cost of generating the forced draft and the possible reduction of ashpit pressure's lowering the boiler capacity. If it can be dumped directly into railroad cars, the basement being deep enough for this purpose, the hopper can be quickly dumped through bottom doors. Where conveyors are installed it is usual to use a side door and work the ashes out gradually into the conveyor to avoid choking it, as would happen with a straight dump. Fig. 3 illustrates a layout of this kind. The conveyor will occupy the trench in front of the ash door. It may be mechanical, bucket or chain, or air or water, and is therefore shown schematically only.

With forward-travel underfeed stokers, chain-grate stokers, front-feed inclined stokers, and others the ashes are dumped at the rear of the furnace and the top of the hopper will be the width of the fire but of small dimension from front to rear to accord with the stoker dump. This reduces the capacity for storage as is seen by examining Fig. 5. Where large storage is imperative, the ashpit may be designed as in Fig. 4, which is drawn from an illustration appearing in *Power* of January 17, 1922. Owing to the flatness of the bottom, some hand labor is necessary to effect complete discharge when desired.

With chain-grate stokers a hopper should also be provided for fine coal which sifts through the grates before ignition. Such an arrangement is shown in Fig. 5. This coal is dumped into some means of conveyance to be returned to the stoker coal hoppers.

Side-travel underfeed stokers dump at each side of the wind box for the whole depth of the fire. Hopper ashpits for this type of stoker may therefore have greater storage capacity since the top of the hopper extends to the front of the boiler.

Capacity. In some instances very little capacity may be sufficient, owing to storage being taken care of outside the ashpit. The method of conveyance from the ashpit will have considerable bearing on the ashpit capacity necessary. But 24 hours' capacity should usually be provided in case of breakdown of conveyors, etc.

Since the required capacity depends upon the amount of ash that accumulates between emptyings, it is controlled by the rate of firing and the percentage of ash in the coal. Multiplying the weight of coal burned between dumpings by the percentage of ash and allowing 40 lbs. per cu. ft. gives the storage space required. Allowance must be made for unburned coal coming in with the ash, for neglect to empty regularly, for possible increase in the load and consequently in the rate of combustion, and for possible change to dirtier coal. The careful engineer will make the capacity of his ashpits perhaps 50 per cent greater than the calculations show, or even more.

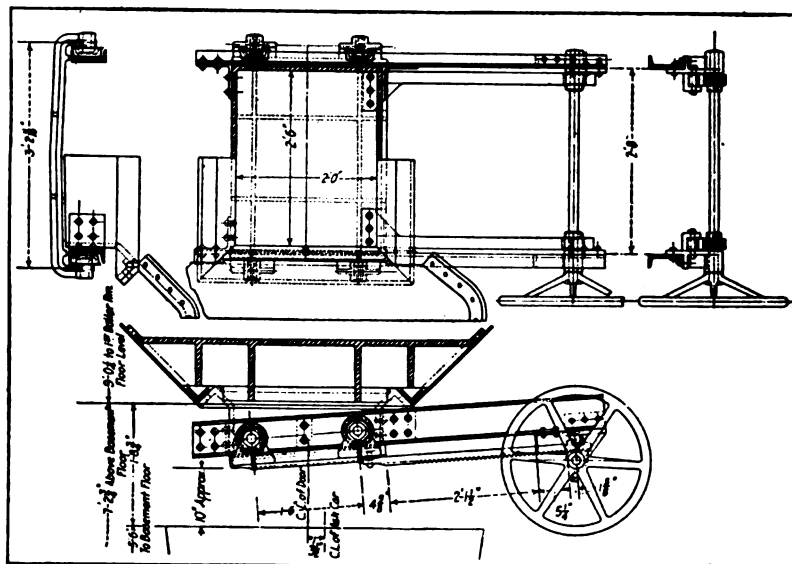


FIG. 7—Assembly of ashpit door and frame.

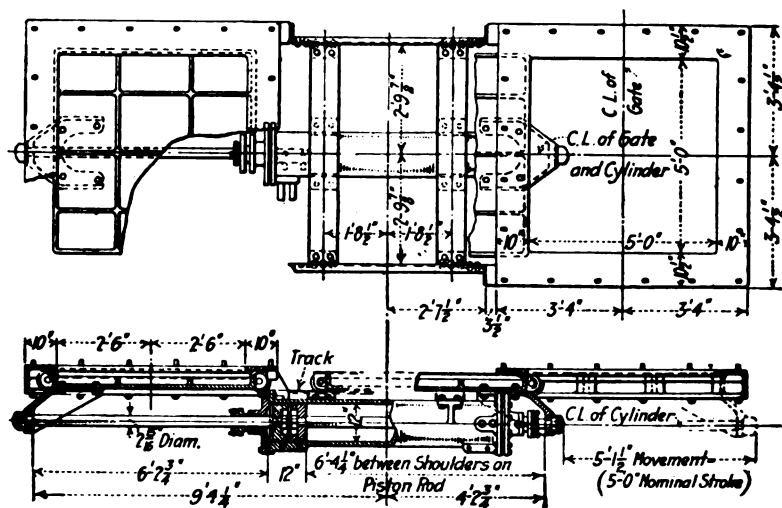


FIG. 8—Baker-Dunbar-Allen power operated ash doors.

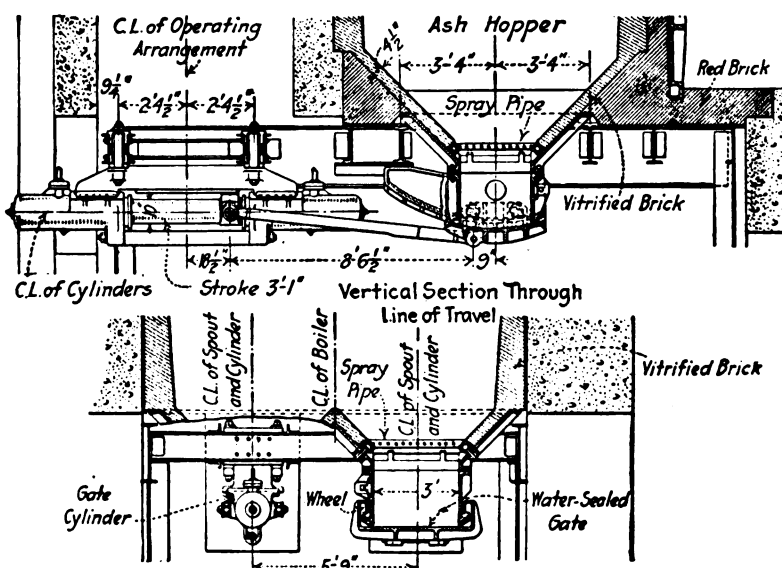


FIG. 9—Diescher power operated ash doors.

Design. The sides should slope at not less than 45 deg. in any case, and a minimum of 50 deg. with the horizontal is preferable. If one side is vertical the opposite side may have the minimum slope; but where two opposite sides slope, neither should slope less than about 55 deg. If the slope is too small, arching of the ash is likely to occur. Where the width of the hopper would necessitate too great height to get these required slopes, the ash-pit may easily be divided so as to have a number of discharge openings. An excellent example of reversed slope which results in absolutely reliable dumping is illustrated in Fig. 13.

If a very small slope is used so as to get large capacity such as in Fig. 4, access doors should be provided at the

to allow a bar to be pushed up into the hopper to clear away any obstruction. In designing new plants ample headroom should always be provided.

Where storage takes place in the ashpit, water spray pipes should be provided for quenching the ashes. These pipes should be near the top and sheltered from the incoming ash. Or a substantial spray ring such as illustrated in Fig. 9 may be used. Many prefer to make the hopper sufficiently large for the ashes to remain long enough to cool naturally. If too much water is used it will leak from the dump doors and flow about the basement; and as it contains much fine ash in suspension, it will clog sewers and necessitate cleaning them frequently.

Construction. Hopper shells made of sheet steel lined with firebrick are undesirable owing to rapid corrosion from sulphur in the ashes. Shells of reinforced concrete about 6 in. thick are common and satisfactory. The

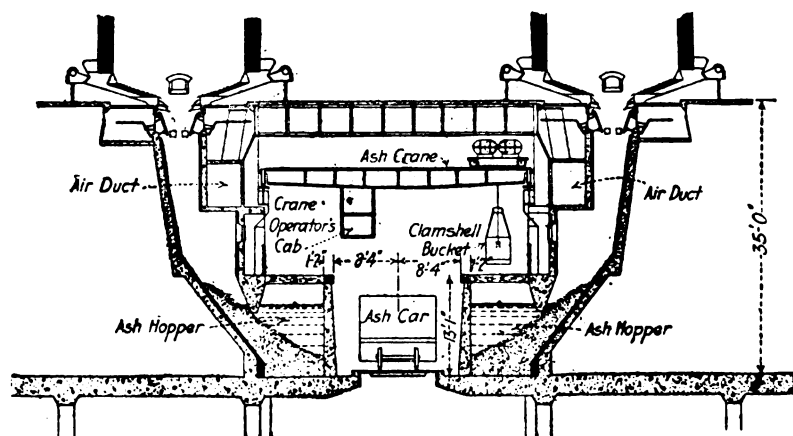


FIG. 10—Water-sealed ashpit.

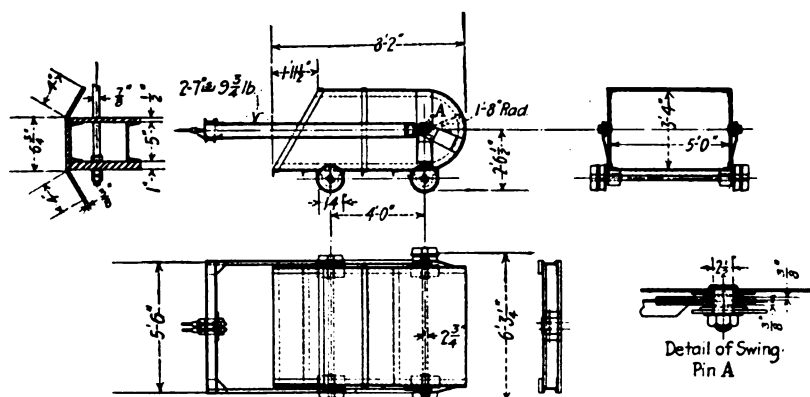


FIG. 12—Details of skip hoist bucket.

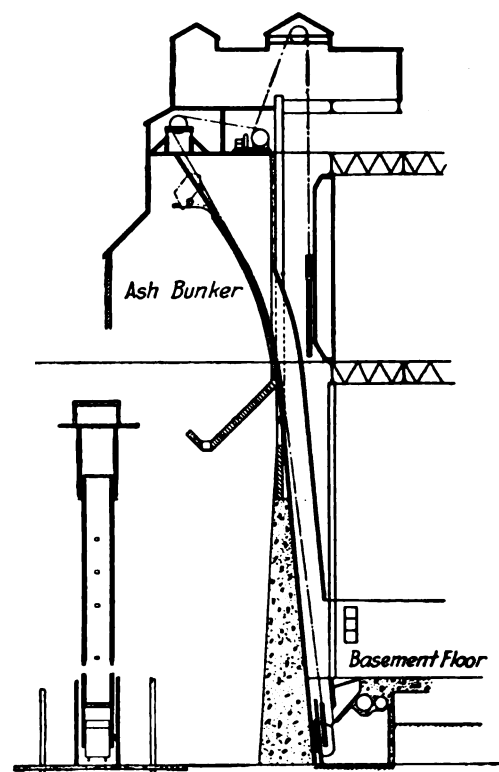


FIG. 11—Skip hoist.

top of the slope so that the ashes may be pushed to the dump doors with a minimum of labor, and ample space should be left so that long ash tools can be welded with ease.

Large discharge openings should be used, though their size depends to some extent upon the method of firing. Modern practice requires 30 to 36 in. as a minimum, with many instances of clear openings 5 ft. square.

The bottom discharge is undoubtedly the least costly in labor and well repays the added expense of the greater height of basement needed. The height of the bottom of the hopper above the basement floor depends upon the system of conveyance adopted. It is greatest where standard railroad cars are used, about 8 or 9 ft. to clear the cars and about 17 to 18 ft. if a locomotive must pass under. With industrial cars 5 or 6 ft. is sufficient, though a clear headroom of 6 ft. 6 in. to 7 ft. is preferable. In any case there should always be sufficient vertical space

most modern construction, and probably the best method so far devised, is to use a structural steel skeleton and make the shell of substantial cast iron flanged plates bolted together.

Owing to the heat of the ashes and the possibility of the combustion of unburned coal, the hopper shells should always be lined with firebrick, which may be of second quality. With proper quenching of the hot ashes with water sprays a lining of well-burned hard paving brick is very satisfactory.

The method of construction of the Baker-Dunbar-Allen hopper ashpit is illustrated in Fig. 6. A suspended skeleton of structural steel carries the hopper shell of heavy cast iron flanged plates. The lining is of special firebrick blocks which will not spall under the temperature changes which occur. As seen in the left-hand view, these blocks are hung from the shell and interlocked in a manner that prevents displacement, but allows of easy

renewal, and no mortar joints are used.

Closures. Hopper ashpits will usually be provided with doors to retain the ash and prevent the passage of air, and to allow of the ash being dumped or hoed out at intervals as desired.

Airtight ash doors are highly desirable in almost all cases. There are several ways in which the dump openings may be sealed. The doors and faces may be machined, or the frame may be provided with a groove packed with asbestos rope, while the door has a rib or tongue which is squeezed into the asbestos packing by a crossbar and screw spanning the door. The latter method has been used with satisfaction in vertical doors like that of Fig. 3. The doors should usually be lined with firebrick to prevent warping due to hot ashes lying on them soon after dumping.

An example of ash door is illustrated in Fig. 7. These doors are of substantial construction, and are carried on rollers running on steel members. They are operated by hand with rack and pinion. Smaller doors are operated by hand, but when the openings approach 3 ft., power operation is advisable for speed. The larger hand-operated doors are worked by gearing, such as rack and pinion, while power operation may be hydraulic, compressed air, or electric.

Fig. 8 illustrates two Baker-Dunbar-Allen dumping doors arranged for compressed air or hydraulic operation. The cylinder is worked between the openings and contains two pistons, one connected to each door. The doors are lined with firebrick.

The Diescher dumping door, shown in Fig. 9, is provided with rollers which run on a curved track. Owing to the curvature of the door in conjunction with the flanges which carry the rollers, it retains water to form a seal and this water renders lining unnecessary. The door can be run off the track and another door run on if replacement is ever necessary by simply removing the pin of the driving connection. There is ample power and strength to shear easily through any clinkers which may get caught during closing.

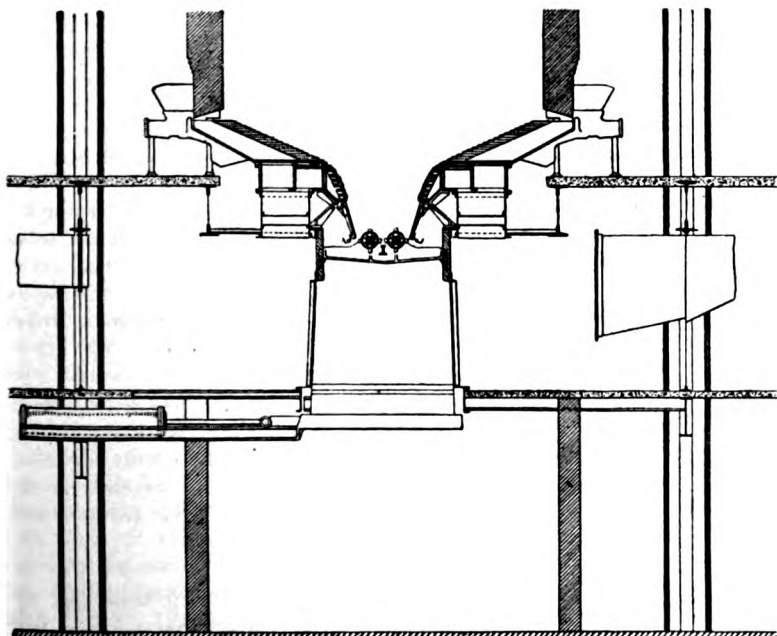


FIG. 13—Hopper ashpit for dumping into standard gondola railroad cars.

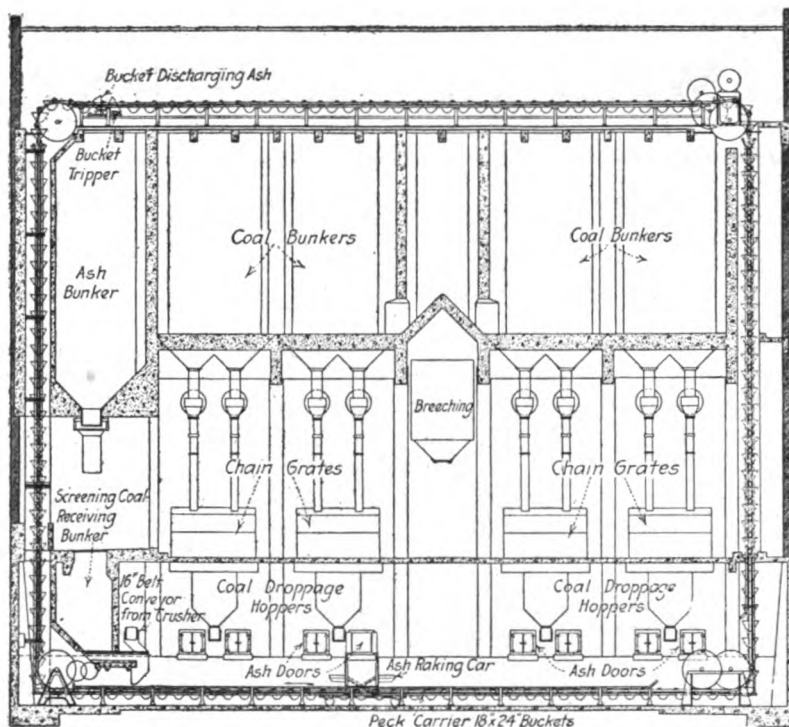


FIG. 14—Peck carrier ring system.

Instead of using doors, closure may be effected by water seal. This method may be described as a U-tube with one leg forming the hopper ashpit while the other is open to the atmosphere and possibly to the entrance of a clamshell bucket. Water in the bend of the U-tube forms a seal and serves to quench the ashes.

An excellent example of this method is illustrated in Fig. 10, which is a cross section of the boiler room of the Springdale station of the West Penn Power Company. More than sufficient water for the seal is provided by the waste cooling water from the clinker grinders. The overflow is from one ashpit to the next, until it is finally discharged from the last ashpit. This system of ashpit requires considerable depth of basement—not less than about 30 ft. from firing floor to basement floor.

A further advantage of this method is that no combustible or corrosive gas escapes into the basement. When boilers are being pushed with heavy loads, gas often escapes from hopper dump doors. Apart from discomfort and danger to those in the basement, considerable corrosion of ironwork often occurs. Such troubles are entirely obviated with the water seal ashpit.

Mechanical Conveyance.

The method of conveying ash by emptying ashpits into small dumping cars has a great deal to recommend it. The cars are inexpensive, can be moved by men, animals, tractors, or locomotives, and can be run about the floor or on tracks, all according to the amount of ash to be moved and other conditions.

In the Ashley Street Station of the Union Electric Light & Power Company, St. Louis, Mo., a system of industrial railway and ash cars was installed in 1905. The basement floor of this plant is 30 ft. below the flood stage of the Mississippi river, and this necessitates a watertight basement with consequent elevation of ashes.

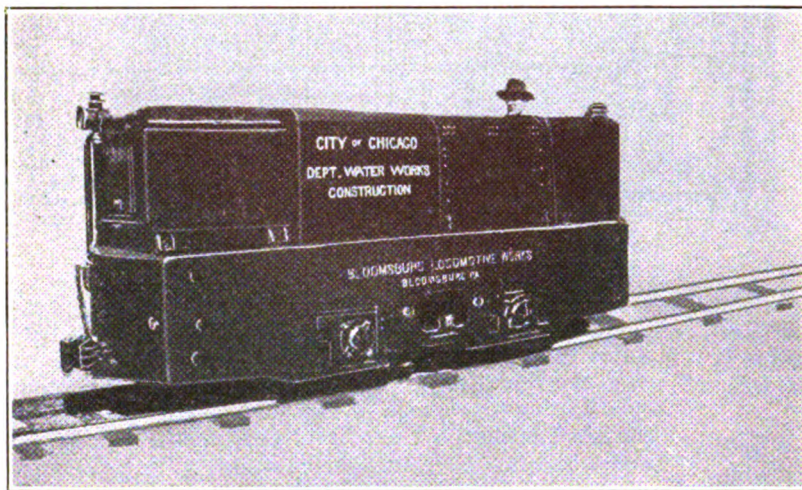
(To be continued.)

WITH THE EQUIPMENT MANUFACTURERS

LOCOMOTIVE FOR INDUSTRIAL PURPOSES

An industrial locomotive in 3½ and 6-ton sizes, which may be furnished with condensers or without, and intended primarily for use in mines, tunnels and other underground work where smoke, gases and steam are objectionable, has been placed on the market by the Bloomsburg Locomotive Works, Bloomsburg, Pa.

These locomotives are equipped with wire wound, quick steaming, fire tube boilers, and a burner which vaporizes the kerosene before burning. This is claimed to eliminate all



Condensing locomotive for industrial work. A 30-hp. semi-flash type boiler, fired with gasoline, and using superheated steam, is employed, the engine being of 20 hp., and roller bearings used throughout. Automatic control of water level and fuel are features.

smoke and reduces the poisonous and noxious gases to a minimum, being approximately one-fifth that of the gasoline locomotive of the same weight. A pilot light is provided which may be left burning when the locomotive is in use for short periods of time. This keeps the water in the boiler warm, and lights the burner when it is turned on.

With this arrangement, it is possible to raise steam in five minutes' time, in cases where the pilot has been burning over night or through the day; it is possible to raise steam, when the water in the boiler is entirely cold and the pilot light has not been burning, within 15 minutes.

The water level in the boiler is maintained automatically, the fire is controlled automatically and the pressure of fuel is regulated automatically. Gauges are provided on an instrument board which indicate whether these automatics are functioning or not and there is also a low water automatic which cuts off the fire and prevents burning of boiler in case the water level should fall below the safety point.

Where exhaust steam is not objectionable, as in outside work, condensers may be eliminated, as the condenser feature adds to the cost of the locomotive. The fuel consumption is said to be between 10 and 15 gallons per day and the water consumption 40 to 50 gallons. The condensing types are claimed to be practically 100 per cent efficient.

MILL TYPE REFLECTOR MANUFACTURED

For use with the new mill type B lamp in mills and factories or any other places subject to severe vibration, the

new mill type reflector has been developed by the Westinghouse Electric & Manufacturing Company.

The mill type B lamp is manufactured with a short P-19 bulb with ring coil filament and in 25 and 50 watt sizes. For severe service in which standard type B lamps prove unsatisfactory, the new mill type lamp, equipped with the mill type reflector has been found to be extremely rugged and serviceable.

The mill type reflector is enameled with porcelain, the outside being green and the inside white. The contour of this reflector is similar to that of the R.L.M. standard dome type, thus assuring efficient distribution of light. This type of reflector may be attached to brass shell or porcelain sockets by means of brass holders.

AIR TIGHT DOOR

The Conveyors' Corporation of America, 326 West Madison Street, Chicago, Ill., has issued a new folder describing the American Air Tight Door. This door is largely used in ash pits and boiler settings and is made in five sizes: 15 x 16, 18 x 18, 22 x 26, 24 x 24 and 24 x 36.

The door is of unique design and is strong and substantially built of cast iron. When closed and locked it is air tight.

NEW BLOW-TORCH

A new blow torch, now being marketed by the Turner Brass Works, Sycamore, Ill., U. S. A., embodies a number of novel, useful and interesting patented features.

Safety Features.

Its makers claim that it is the only blow torch with a safety valve. This valve, located at the end of the horizontal pump cylinder, is fitted with a diaphragm accurately proportioned to give away automatically at 40 lbs. air-pressure. As torches operate at 18 to 20 lbs. pressure, this valve will not come into action until about double normal pressure is present. A thumb-nut on this valve permits the operator to release the air pressure, after his work is done, or to decrease pressure, after his work is done, or to decrease pressure as desired during the operation of the torch.

Another exclusive feature of this line of torches is the fact that there is but one opening in the tank. This opening is at the top, above the fuel line, and is sealed by the screw-thread filler-plug. By eliminating such soldered connections as burner inlet and upper and lower pump brackets, a frequent cause of leakage-trouble is removed.

Parachute-Principle Pump.

The pump on this line of torches is equipped with a pump leather that spreads like a parachute on the work-stroke and, like a parachute, closes on the return stroke. This leather is automatically lubricated from a reservoir of vaseline in the brass washer at the end of the pump rod. These features tend to insure maximum labor.

"Brains" in the Torch Head.

The sturdy, safe, smooth-functioning torch body just described, is surmounted with a torch-head that may be said to play a "thinking" part in doing its daily work.

IMPROVEMENTS IN BOARD HAMMER DESIGN

The Erie Foundry Company of Erie, Pa., one of the leaders in the development of steam hammers, has brought out a new line of board drop hammers characterized by a refinement of detail rather than by any radical departure from accepted principles of construction. Many ideas developed by actual forge shop experience and now considered as standard in heavy steam drop hammer construction have been adapted to the new line of board drop hammers. A thorough study was made of the troubles experienced with existing types, and practical drop forgers were consulted as to the best method of correcting these faults, the ideal of the builders being to achieve a machine capable of a high rate of production, at a minimum of operation and maintenance expense, and dependable even under the severe conditions to which drop hammers are subjected.

Among the outstanding features of the new hammer, as described in a bulletin just issued by the manufacturer, are wedge adjustment of the frames across the anvil, the use of tie bolts and separators between the frames at the bottom, and a new type of latch.

Heretofore the use of wedges for adjusting the frames across the anvil has been confined to heavy steam hammers. However, wedge adjustment has been adopted for this line of board drops, eliminating the usual screw adjustment, and its attendant troubles. The wedges hold the frames and anvil together as a solid unit, making it easy to maintain the alignment of dies, and at the same time making adjustment easier. The use of wedges and the design of the tongue and groove construction between frames and anvil, prevents scale from working into this joint and increasing wear.

Another factor tending to maintain the alignment of the whole machine is the use of tie bolts and separators between the frames, top and bottom, front and rear. The separators prevent binding of the ram in the guides, and yet minimize the amount of play; their length can be reduced to compensate for wear of the guides or planing down.

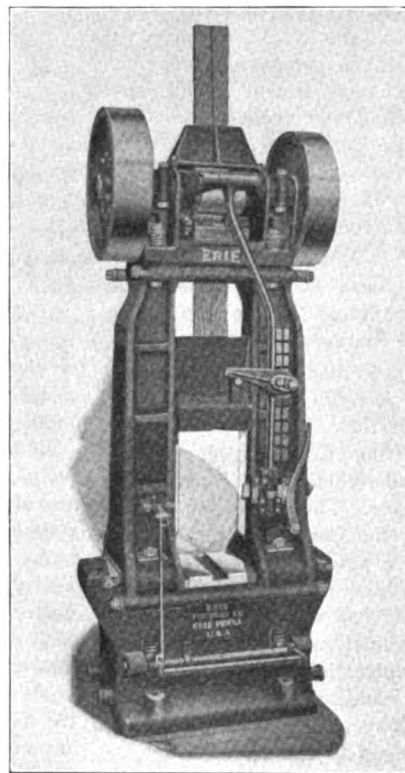
The ordinary construction, with screw adjustment, and without bottom separators and tie bolts, is in action like a number of small bars, placed end to end, and under compression, for the screws have practically a point bearing on the frames, and the bearing of the ram in the ways is narrow. The tongue and groove joint between the frames and anvil is all that prevents a tendency to buckle, and as soon as the sides of this joint wear, the frames and ram can buckle sideways enough to throw the dies out of alignment and give mismatched forgings. The new type Erie hammer has greatly increased the area of the tongue and groove, and the elimination of screws closes the opening through which most of the scale worked which caused wear at this point. The tendency to buckle has been entirely removed, however, for the wedge provides a broad flat bearing back of the frame, and between the frames the separators are placed at the extreme front and back, so that pressure tends to square up the frames against the spacers. On the larger sizes, double V's are used between the ram and the guides.

Several details of the operating mechanism have been improved. The point of knock-off is easily adjusted, assuring that adjustment will be made as often as desirable and that the rolls will grip the board at just the proper moment. The friction bar drops vertically in guides, the latch bar being moved by the descending ram from under a block which fits against a shoulder on the bar. As the ram ascends, a hickory pin strikes one end of the roll release lever, which is pivoted on a block clamped to the friction bar. Thus the friction bar is lifted gradually and without shock. The other end of the roll release lever bears on a pin which is adjustable up and down on a rack cast on the frame, by means of which the length of stroke is varied. A cross-bead construction used at this point reduces wear and shock.

The sow block is of forged steel, held in the anvil by planing

one side to a V, a double ten degree angle, also tapering in a vertical plane, so that the harder the block is hammered, the tighter it is held.

Examination of the specifications shows the high grade of material which is used. For example, chrome nickel steel forgings are used for the various parts of the latch and roll release



mechanism. The friction bar also is of chrome nickel steel, as are the roll shafts, the housing bolts, the roll housing bolts, and a number of the less important connections.

The ram is an open hearth steel casting, cast by a special process to assure a dense structure of clean metal.

The main bearings are bushed with phosphor bronze, and ample bearing area is provided.

The anvils can be furnished in the ratio of 15 to 1 or of 20 to 1 to the weight of ram. The frames and anvil are semi-steel in the standard hammers, but they can be furnished from open-hearth steel castings. Likewise, the ram can be either forged or cast steel, and the pulleys of wood, paper, or steel, to suit individual requirements.

BOOK REVIEW

Oxy-Acetylene Welding and Cutting, by P. F. Willis; cloth, 254 pages, 4 x 6 1/4 inches; published by the Norman W. Henley Publishing Company, New York, price \$1.50.

This is the sixth edition of this book which has been revised and enlarged by the addition of new matter and engravings. The volume is intended to instruct in the case of apparatus, welding of all metals and alloys, care of expansion and contraction, soldering aluminum, repairing scored cylinders, etc. It should be of use to manufacturers, metal workers, garage men, railroad operators, blacksmiths, etc.

The three types of welding, namely, acetylene, oxygen and electric, are explained as well as the various types of apparatus used in the execution of each method. A discussion of the methods and tools necessary in the preparation of the metal for weldig as well as a description of the various metals that are adopted to welding is included. Other chapters deal with welding of sheet metal and pipe, boiler welding, welding of various pieces, and welding symbols.

TRADE NOTES

The Koppers Company has received a contract from the Bethlehem Steel Company covering the construction of 114 Koppers Improved Type ovens at their Lackawanna plant, Buffalo, N. Y., arranged in two batteries of 57 ovens each, together with by-product and benzol plants, coal and coke handling equipment, etc. Construction will be started at once and it is expected that the plant will be completed within a year or 15 months. There are now in operation or under construction 622 ovens of Koppers Improved Type.

The H. M. Lane Company, Industrial Engineers, have moved from the Owen Building to 333 State Street, Detroit, Mich.

Announcement is made by the Conveyors Corporation of America, 32 Madison Street, Chicago, Ill., of their acquisition from the Green Engineering Company, East Chicago, Ind., of all rights to the Green Steam Jet Ash Conveyor. The acquisition of this business places the Conveyors Corporation of America in a position of superiority in the steam jet ash conveyor field. The company has already had an interesting career, being an amalgamation of the Griffin Engineering & Contracting Company and the Girtanner, Daviess Engineering and American Steam Conveyor Corporation. The name was changed to the Conveyors Corporation of America in the fall of 1920.

Railway Equipment Company, 235 Stark Street, Portland, Ore., have moved their offices to 104 First Street, Portland.

The fifth annual report to stockholders has just been issued by the Pittsburgh Rolls Corporation, Phoenix Roll Works. Officers: D. L. Eynon, president; Q. S. Snyder, vice president and treasurer, and P. M. Fleming, secretary. Directors: C. C. Smith, chairman; D. L. Eynon, J. P. Allen, G. W. Eisenbeis, W. S. Evans, J. J. Turner, L. M. Shoemaker, W. H. Nichols and Q. S. Snyder.

McLain's System—This exhibit will consist of samples of semi-steel castings of light section, such as cylinders, pistons, piston rings, gears, etc. Hatchets, hammers, pliers and automobile tools of annealed semi-steel. You are invited to inspect the lessons known as McLain's System of cupola practice, gray iron and semi-steel—or steel foundry practice covering all processes of making steel. Represented by David McLain and I. V. Scanlan.

F. J. Ryan & Company, Philadelphia, Pa., have been awarded contracts from the Pennsylvania Forge Company for the installation of the new continuous billet heating furnace and for the new pit wire annealing furnace for the Gulf State Steel Corporation of Birmingham.

Frey, Brassert & Company have been engaged as consulting engineers by the Co-

lumbia Steel Corporation, San Francisco, Cal., for the construction of their new blast furnace plant at Provo, Utah.

TRADE PUBLICATIONS

Boiler Furnace Economies—Quigley Furnace Specialties Company have recently issued two bulletins on refractories under the titles of "Boiler Furnace Economies" and "Refractory Concrete Lining." The first presents interesting details of the use of Hytempite in the reconstruction of boiler furnace walls, using crushed fire brick or other ganister bound together with Hytempite. The second illustrates in detail the use of Mono-line for repairing cupolas, the lining of large and small ladles, converters in the Bessemer process, also linings in metal melting furnaces in the non-ferrous industry.

Boiler Meters—The Bailey Meter Company of Cleveland, Ohio, have recently issued Bulletin No. 8, which is devoted to a description of their various products; the boiler panel, boiler meter, multipointer gage, Bailey fluid meter, Bailey Weir meter, Bailey gas and air meter, Bailey tachometer, Bailey meter for coal and granular material and the gravity recorder for liquids. A vestpocket calendar indicating the dates of the chemical and power shows accompanies this bulletin.

Link Belt's Advertising Organization—An interesting reprint from *Class*, covering the publicity methods employed by Mr. Julius Hall, advertising manager of the Link Belt Company, Chicago, has appeared. It goes into complete detail of the advertising organization, with graphic descriptions of the various sub-divisions used.

Selection of Fuel Oil Burners—Tate, Jones & Company, Inc., are issuing a bulletin describing their various types of oil burners under the title, "Fuel Oil and Its Use."

Metals Goods—L. F. Grammes & Sons, Allentown, Pa., have issued a small booklet describing their service in the manufacture of many different types of metal, ware, appliances and stampings. They point out their ability to manufacture 12,000 different metal articles in one plant.

Platforms and Boxes—The Truscon Steel Company, Youngstown, Ohio, has published a 16-page illustrated booklet in which platforms and boxes and other equipment for handling material are described and illustrated.

Milwaukee—An attractive 32-page illustrated booklet has been published by the Milwaukee board of harbor commissioners, containing an historical, descriptive and prospective treatise on the port of Milwaukee. Harbor work is described and illustrated, as is the development of trade in coal, grain, etc.

Speed Reducers—Spur gear speed reducers are described and illustrated in a 96-page booklet which the W. A. Jones Foundry & Machine Company, Chicago, recently issued. This reducer is designed for stepping down speeds between electric motors and driven machines. The reduction is obtained by an enclosed spur gear drive, constructed so that all moving parts operate under favorable conditions in an oil bath. The high speed shaft and the low speed shaft are concentric and have the same direction of rotation. A flexible coupling connects the motor shaft to the high speed reducer shaft, permitting the armature shaft of the motor, while operating, to float freely in its bearings. Another flexible coupling connects the low speed reducer shaft to the shaft of the driven unit, causing rotation at any predetermined speed to suit the requirements. The final speed depends on the revolutions per minute at the motor and the reduction ratio selected in the reducer.

Trucks—The Sabin Machine Company, Cleveland, has published a 12-page booklet in which factory trucks are described and illustrated. The trucks have frameworks of electric steel castings and angle iron. The wheels are of semi-steel, heavily ribbed to withstand shocks and are of large diameter to facilitate easy rolling. They are machine finished. Axles are machined from 0.40 per cent carbon steel. An extension foot pedal is used on all trucks with the exception of one tube. This increases the leverage and makes it easy for a man of medium build to "break over" loads up to 1,600 pounds, eliminating the need for helpers. Steel handles are furnished as standard equipment and all trucks are equipped with legs so they will stand in an upright position when not in use. Specifications and uses of various types are given.

COMING MEETINGS

April 3-7—American Chemical Society will hold its spring meeting at New Haven, Conn. L. Parsons, P. O. Box 1515, Washington, is secretary.

April 18-20—Society of Industrial Engineers spring convention will be held in Cincinnati. The headquarters of the society are at 327 South La Salle Street, Chicago.

April 19, 20 and 21—The seventh annual meeting of the American Gear Manufacturers' Association will be held at Hotel Cleveland, Cleveland, Ohio. The detailed program for this meeting is being prepared by a competent committee and will be announced as soon as it is completed. T. W. Owen, 2443 Prospect Avenue, Cleveland, is secretary.

May 2-4—National Foreign Trades Convention will be held in New Orleans.

NEWS OF THE PLANTS

The Diamond Steel Products Company, Minneapolis, Minn., recently organized, has purchased the local plant of the Allied Tractor Company, Marshall Street, N. E., for a new steel works. The present buildings will be improved and necessary equipment installed. Plans have been perfected for the construction of a new addition to cost about \$100,000, including machinery, and it is proposed to break ground for the structure at an early date.

The Metal & Thermit Corporation, 120 Broadway, New York, has plans in preparation at the office of its engineering department for the erection of a new rolling mill at South San Francisco, Cal. A tract of 14 acres of land has been secured for this purpose and the ground will be staked out at an early date. In addition to the main rolling mill, a number of auxiliary buildings will be erected, the entire works with machinery being estimated to cost approximately \$1,500,000. The company is now operating a plant of another character in the vicinity of the new mill.

The Witherow Steel Company, Pittsburgh, Pa., has plans in progress for extensions and improvements at its plant at Neville Island, to double, approximately, the present capacity. The company has recently formed a merger with the River Front Land Company in this section, and has advanced its capital to \$2,800,000, for general expansion. W. P. Witherow is president, and Joseph Dilworth secretary of the company.

Witherbee, Sherman & Company, New York, are planning for the early blowing in of their blast furnace at Port Henry, N. Y., which has been deferred for a number of weeks owing to coke shortage. The plant has been idle for close to a year, during which time a number of improvements and extensions have been made. This work includes the building of a new blast furnace, which is expected to be ready for service early in April. The unit will have a rated capacity of 500 tons a day. The other blast furnace will run on a capacity of 250 tons of pig iron per day, utilizing magnetic ore.

The Blackwood Electric Steel Corporation, Parkersburg, W. Va., recently organized, has commenced the erection of its proposed new local plant, to consist of a number of one-story buildings, with main structure 140x230 ft. The initial plant with machinery is estimated to cost \$100,000. A general contract for the structures has been awarded to Plate & Vogel, Parkersburg. Mills, Rhines, Nordoff & Bellman, Ohio Building, Toledo, Ohio, are architects for the work. F. S. Blackwood is president and general manager.

Joseph E. Thropp, Inc., Philadelphia, Pa., recently reorganized, is planning for general expansion in plant facilities and operations. Arrangements are being made for the blowing in of the blast furnace at Everett, Pa., for the production of pig iron. The company also proposes considerable activity at its furnace at Saxton, Pa., and it is understood that improvements will be made at this location. The new organization will operate with enlarged working capital, and has recently been formed under Delaware laws with a capital of 30,000 shares of stock, no par value. Joseph E. Thropp is president.

The Ashland Steel Company, Ashland, Ky., manufacturers of steel billets, ingots, etc., is planning for increased operations at

its plant, and it is expected to place the billet mill and open hearth furnaces on a full production schedule at an early date, with complete working force. The rod mill at the plant is now in service on a single turn.

The Bethlehem Steel Corporation, Bethlehem, Pa., is arranging for the blowing in of another blast furnace at its Steelton, Pa., works at an early date. A number of improvements and repairs will be made at Furnace E at the plant, and this unit placed in service in the near future. Other departments at the local works will also engage under an advanced schedule.

The Hunter Crucible Steel Company, Cleveland, Ohio, recently organized, has acquired the plant of the Electric Steel & Forge Company, Grant Avenue, and proposes immediate operations at the works. The property was secured for a consideration of about \$600,000, and a number of improvements and extensions will be made, including a one-story extension, 65x100 ft. A new crucible furnace will be installed and important changes made in the rolling mills. To provide for the extensions, as well as for additional working capital, the company is arranging for a security issue of \$1,000,000, divided into notes of \$500,000, and \$500,000 in preferred stock. Arthur H. Hunter, formerly president of the Atlas Crucible Steel Company, Dunkirk, N. Y., is head of the new organization. F. D. Lounsbury is first vice president and manager of the works.

Henry R. Potts & Company, Philadelphia, Pa., have acquired the blast furnace of the Pottstown Iron Company, Pottstown, Pa., which is of old type and inactive for some time past. It is purposed to dismantle the unit and remove the equipment to another location.

The United Steel Company, Everett, Wash., has completed its plant at Lowell, near Everett, which has been in course of construction for some time past, and will place the plant in service at an early date. The main works consists of a 12-in. merchant bar mill, five stands, three high, and a number of auxiliary buildings.

The Carnegie Steel Company, Pittsburgh, Pa., has active work in progress on an addition to its by-products plant at Clairton, Pa., and proposes to push the construction to early completion. The present plant consists of 640 ovens, arranged in ten batteries of 64 each. The new extension will provide for 366 new coke ovens and by-products plant.

The Lorain Steel Company, Johnstown, Pa., has construction in progress on a new building at its plant to be used for general operations. Considerable additional equipment will be installed, including electrical apparatus for works in operation.

Radcliffe Romeyn, who has been vice president of the American Manganese Mfg. Company, with offices in Philadelphia and furnaces and coke ovens at Dunbar, Pa., has severed his connection and accepted the position of assistant sales manager of the Bituminous Coal Department of Madeira, Hill & Company, North American Building, Philadelphia. During the war he was a major in the Ordnance Department and was connected with the trench mortar troops of the American Expeditionary Forces.



Sam Heppenstall has been elected chairman of the board of directors of Heppenstall Forge & Knife Company, Pittsburgh, and C. W. Heppenstall has been elected president to succeed him. S. B. Heppenstall continues as vice president and Floyd Rose as secretary.

✓ ✓

W. J. Stoop, vice president in charge of operations of the Wheeling Steel Corporation, has been elected a director, succeeding Andrew Glass, resigned.

✓ ✓

Pickands, Mather & Company, Cleveland, announce that Samuel E. Bool and Frank Armstrong have been admitted to membership in that firm. Mr. Bool has been associated with the firm 35 years in various departments, and Mr. Armstrong has also been connected with it many years, in various capacities in the coal mining department. He was recently assistant to G. D. Cameron, who resigned as manager of the firm's coal department late last year, and has succeeded Mr. Cameron as manager of that department.

✓ ✓

W. B. Parry, superintendent steel works, South Division of the Alloy Steel Corporation, Canton, Ohio, has resigned his position, effective February 1. Mr. Parry was formerly superintendent of the Lowellville plant, Sharon Steel Hoop Company, and prior to that time was superintendent of rolling department at North Works, Carnegie Steel Company, Sharon, Pa.

✓ ✓

James H. Anderson has been appointed foundry superintendent for Sweet & Doyle, Green Island, N. Y.

✓ ✓

George M. Thompson, former vice president and general manager of the Wickwire-Spencer Steel Corporation, Worcester, Mass., has been named president and treasurer of the recently organized Thompson Wire Company, Boston, Mass. Allan L. Cowperthwaite, formerly of the Goodard Works of the Wickwire Spencer organization, is secretary and general manager of the new company.

✓ ✓

J. B. Kennedy, chairman of the board of directors; James H. Grose, president, and George F. Alderdice, vice president in charge of sales of the Brier Hill Steel Company, Youngstown, Ohio, are expected to continue with the Youngstown Sheet & Tube Company, which has taken over the former company.

Hugh J. Garvey, vice president of the Valley Mould & Iron Corporation, will sever his connection with that concern on March 1 to devote his entire time to the Sharpsville Boiler Works Company, as chairman of the board.

✓ ✓

T. E. Selen has resigned as assistant manager of the Massillon, Ohio, plant of the Griscom-Russell Company, which position he has held since 1918. Previous to his connection with the Griscom company he was secretary and treasurer of the Prescott Company, Menominee, Mich., manufacturers of marine engines, pumps, etc.

✓ ✓

Henry T. Chandler, chemical and metallurgical engineer, also formerly research engineer of the Ford Motor Company, and more recently an associate of C. Harold Wills of C. H. Wills & Company, has become associated with the Vanadium Corporation of America as metallurgical engineer, with headquarters in Detroit.

✓ ✓

E. S. Lammore, test engineer since 1919 of the Lorain, Ohio, works, National Tube Company, has returned to the Westinghouse Electric & Mfg. Company, with which he was affiliated from 1913 to 1919. He will be in charge of controller sales in the industrial department.

✓ ✓

F. M. Gibson, who formerly represented the Consolidated Steel Corporation in Japan, will represent the Bethlehem Steel Export Corporation at Tokio, as engineer salesman, and is scheduled to leave New York on February 1 to sail from San Francisco on February 8.

✓ ✓

W. A. Barrows, Jr., president, and J. E. Rotthaus, assistant to president, announce their retirement from Thomas Iron Company, Hokendauqua, Pa., and the formation of the firm of Barrows & Rotthaus, offices 807 Widener Building, Philadelphia, Pa. The new firm will engage in the sale of pig iron, iron ore, coal and coke.

✓ ✓

The Earl of Middleton, a director of the Barrow Hematite Steel Company, Ltd., Barrow-in-Furness, Lancashire, England, has arrived in the United States for a business trip and is spending a few days of this week at the home of W. S. Pilling, Philadelphia iron merchant. Mr. Pilling will leave on Friday for Florida, to be gone about a month.

Some Pointers on By-Product Coke Oven Operations

REPORT OF LIGNITE CARBONIZING EXPERIMENTS CONDUCTED AT GRAND FORKS IN 1922

The Bureau of Mines, Department of the Interior, has just issued the report of their lignite carbonizing experiments conducted at Grand Forks during 1922, serial No. 2441.

1922 Co-operative Agreement.

The results of the 1921 co-operative experiments conducted by the U. S. Bureau of Mines and the University of North Dakota at the University mining substation plant at Hebron, N. D., pointed clearly to certain definite deficiencies in the scheme hitherto developed for benefiting and utilizing lignite.

First—The apparatus used in the carbonizing process or used to produce carbonized lignite suitable for briquetting is too costly, that is, the cost per ton day of residue made is too high.

Second—The depreciation of the carbonizing apparatus is too high.

Third—The carbonizing apparatus cannot be operated intermittently without seriously damaging it and impairing its efficiency of performance.

Fourth—Too little attention has been given to the possibility of using at least a certain percentage of the carbonized lignite directly in suitable stoves and furnaces without briquetting or other treatment.

Accordingly, consideration was given to the design of an oven that could be built at a mine without the importation of highly skilled and specially trained construction men, erected at a low first cost, readily kept in a state of repair, operated at a relatively high capacity and put into operation or shut down at will without seriously damaging the brickwork. The need of such an oven was appreciated also by the University of North Dakota and a co-operative agreement was made to build and operate such an oven during the summer of 1921.

Carbonizing Oven.

The oven is essentially a vertical shaft with means for supplying raw lignite at the top and discharging the carbonized lignite at the lower end. It was believed that carbonization would be brought about by maintaining a combustion zone at the middle of the oven, passing the lignite through this zone too rapidly for complete combustion, but slowly enough to maintain a state of combustion by merely supplying air under slight pressure through air ports opening into the combustion zone. It was also believed that by controlling the rate of discharge and the rate of air input, the degree of carbonization could be controlled and that, other things being the same, carbonization would be more complete as the air input was increased or as the rate of discharge was decreased. Expressed differently, the capacity, other variables being the same, should depend on and vary with the rate of air input. It was anticipated that one row of air ports would not maintain a large enough hot zone to carbonize lignite completely at the desired point and that a greater opportunity for economy would be afforded by employing a double row of air ports on each side of the oven.

Carbonized lignite cannot be so conveniently handled as coke on being removed hot from an oven, hence it was deemed necessary to provide a special discharge and cooling apparatus which is incorporated as a part of the oven. The cooling chamber was arranged to expose a large surface of the carbonized product to the action of steam or water, which were supplied through pipes entering at the top of the cooler. The baffles which provide this cooling surface are of themselves a means for bring-

ing about a mixing of the particles in transit through the cooler.

The large cast iron pipe just above the cooling chamber was intended to prevent jamming and to take some of the weight off the baffles in the cooler.

It was thought that because of the larger size of the lignite particles above the combustion zone than below it, the gaseous products of combustion along with some unconsumed combustible gas from distillation would pass upwardly and out of the top, and that the depth of fuel below the air intake ports was sufficient to act as a seal to prevent gases from passing downwardly and out through the discharge. No water seal was provided with this oven, nor any means of recovering by-products.

The ovens as described was built in June and July and operated up to the forepart of September, 1922. The estimated capacity of this oven, using a nominal amount of air, was (10 tons of raw lignite) approximately four tons of carbonized lignite per 24 hours.

The complete report covers 26 bulletin pages, and contains many useful charts, tables and diagrams.

The Republic Iron & Steel Company, Youngstown, Ohio, is arranging for a number of extensions in its local mills, and as a forerunner of projected works, will commence the early installation of a new by-products plant, consisting of about 60 new type combination ovens of the Koppers Company, Pittsburgh, Pa. The plant will develop an output of about 1,275 tons of metallurgical coke per day, with carbonizing capacity of close to 1,825 tons of coal. The company is now operating seven blast furnaces in the Youngstown district.

✓ ✓

The Weirton Steel Company, Weirton, W. Va., has extensions under way at its plant, including a new sheet mill, by-products coke ovens and auxiliary structures. The work will comprise the installation of considerable new machinery and operating equipment, with new boiler plant apparatus. It is expected to have the buildings ready for service at an early date.

✓ ✓

Dr. Raymond M. Howe, who for the past four years has been senior fellow of the Refractories Manufacturers' Association at the Mellon Institute of Industrial Research, University of Pittsburgh, has resigned to become associated with the Kier Fire Brick Company, Pittsburgh. In his new connection Mr. Howe will devote his time to technical problems arising in both the sales and promotion branches of the Kier company, and will do research work. His successor at the Mellon Institute is M. C. Booze, who has been with the Norton Company, Worcester, Mass., and previously was attached to the Bureau of Mines.

OBITUARY

George A. Taylor, district sales manager at Boston for the Youngstown Sheet & Tube Company since November, 1908, died at his home in that city on January 23, after a comparatively brief illness. Mr. Taylor was born at Boston on February 29, 1856, and had spent his life in the steel business, beginning as a boy with the National Tube Company at Boston. Later he was connected with a number of concerns, joining the Youngstown Sheet & Tube Company in November, 1908, and being assigned to the Boston office as manager. Mr. Taylor was a gentleman of rare personality and was greatly beloved by all of his associates.

ADDITIONAL TRADE ITEMS

Among the very recent notable sales of Uehling CO₂ recording and indicating equipment are eight units for the Detroit Edison Company, making a total of 65 such units purchased for the different plants of that company since 1911. The famous River Rouge plant of the Ford Motor Company has also added two units to its present Uehling equipment. This company has now a total of 21 units in operation. The application of this equipment to the River Rouge plant is of particular interest since the boilers are of unprecedentedly large size and are novel in their use of a mixture of blast furnace gas and powdered fuel.

Mitsui & Company have just been appointed exclusive representatives in Japan and China for Uehling CO₂ recording equipment, and other Uehling power plant instruments and gauges. The head office of Mitsui & Company is located in Tokio and their New York branch office is at 65 Broadway. The main office and factory of Uehling Instrument Company is in Paterson, N. J. Many Uehling installations have been made in Japan and China without the aid of local representatives, but it is believed that with the co-operation of the very able engineering department of Mitsui & Company, the Japanese and Chinese Uehling customers will be served to the very best advantage.

The Commonwealth Edison Company of Chicago has ordered from the Westinghouse Electric & Mfg. Company a 50,000-kw. cross compound turbine generator for its new Crawford Avenue Station. This unit has many new interesting features, the main one being its very high steam pressure. The boilers will be designed to produce steam at 600 lbs. pressure, although at first a steam pressure of 525 lbs. will be used. The temperature of the steam at this pressure will be 750 deg. F. The high pressure unit will develop 12,500 kw. and the steam after leaving this unit will be reheated to 700 deg. at 122 lbs. pressure. The full load rating of 50,000 kw. will be carried on one valve, this being the best point of efficiency, as it is to be used as a "base-load" machine. For its Calumet Station the Commonwealth Edison Company recently ordered another Westinghouse 37,500-kw. tandem compound turbine generator.

Work on the first high voltage porcelain insulator works to be built west of the Mississippi river has been begun at Emeryville, Cal., near San Francisco, by the Westinghouse High Voltage Insulator Company of Derry, Pa., a subsidiary of the Westinghouse Electric & Mfg. Company of East Pittsburgh, Pa. The plant at Emeryville, which is in the heart of the great western hydro-electrical power district, will fill the need for such a plant to sup-

ply the demand for insulators in that district as well as in other sections of the West and in the Pacific coast district. The foundation of the plant, which will be of brick, wood and concrete construction, and will be situated at Sixty-second and Green streets, Emeryville, has been laid and work will be pushed forward as rapidly as possible. It is expected that this new Westinghouse plant will be completed and ready for use within three months. It will have a floor area of approximately 60,000 sq. ft. R. P. Jackson, who will manage the plant, said: "It has become apparent that one of the large markets for line insulators is on the Pacific slope. In fact, the water power resources of the coast and intermediate states exceeds 35,000,000 hp. and is approximately 80 per cent of that of the entire country. This means a great future demand for the line insulators. For this reason the officials of the Westinghouse Electric & Mfg. Company made a survey of the coast cities and decided that the territory contiguous to San Francisco offered the best opportunity for general manufacture. Accordingly, a tract of the land of about 12 acres was purchased in Emeryville to provide for future needs in manufacturing space. The first undertaking is the erection of the insulator factory as a branch of the Westinghouse High Voltage Insulator Company. The building, on which work has just been started, will contain four oil burning kilns for firing the porcelain ware with a possible extension of the plant to 12 kilns. The immediate demand will be for the employment of a working force of about 100 with a possible increase to 300 when the building is enlarged. Marsden H. Hunt, ceramic engineer of the Westinghouse Electric & Mfg. Company, is superintendent of the new plant.

Enormous expansion of power stations is shown by recent contracts for Westinghouse steam turbine generators: 62,500 kva., Brooklyn Edison Company, Hudson Street; 50,000 kw., Commonwealth Edison Company, Crawford Street; 37,000 kw., Commonwealth Edison Company, Calumet; two 30,000 kw., West Penn Power Company, Springdale; three 25,000 kw., Connecticut Light & Power Company; two 25,000 kw., Middle West Utilities Company; two 25,000 kw., Indiana Public Service Company; 25,000 kw., Counties Gas & Electric Company, Norristown, Pa.; 25,000 kw., Denver Gas & Electric Company; 25,000 kw., Moline & Rock Island Mfg. Company; 25,000 kw., Luzerne County Gas & Electric Company; 25,000 kw., Public Service Production Company, Jersey City; 25,000 kw., Lorraine (Ohio) County Gas & Electric Company; 25,000 kw., Pennsylvania Railroad, Long Island City; 37,500 kw., Toledo Edison Company; 37,500 kw., Metropolitan Edison Company, Reading, Pa.

The Hartford, Conn., Gas Light Company is adding a 11-ft. cone top set to its

plant equipment. The set will have a daily capacity of 2,725,000 cu. ft., and will be hydraulically operated. It will also be equipped with the U. G. I. thermo automatic control.

The U. G. I. Contracting Company of Philadelphia has lately received orders for its new barring-down machine from the Lynn, Mass., Gas & Electric Company and the Hartford, Conn., Gas Light Company.

The Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanical Arts, acting through its Committee on Science and the Arts, has awarded Mr. H. A. Greaves jointly with Mr. H. Etchells, B.Met., its Certificate of Merit for notable and original inventions embodied in the "Greaves-Etchells" type of electric steel melting furnace. The Science Committee has thoroughly investigated the claims and patents of the inventors, have inspected and tested furnaces in operation, and report they were favorably impressed by what they witnessed. The original patent No. 1,257,997 shows an arc furnace supplied with either a two-phase or a three-phase current, having current distribution so arranged that the conducting hearth of the furnace forms one electrode of the circuit. Extracts from the Science Committee's report state: "This arrangement of transformers makes it impossible for a short circuit to occur at *a* or *b* (top electrodes) and *o* (the whole of the furnace hearth) without forcing the current to pass through two transformer windings in series. The damping effect of this extra current minimizes the danger of sudden overloads on the supply system and is a distinct advantage in this type of furnace. A second U. S. Patent No. 1,301,932 shows 14 groups of transformer windings that are variations of the original device. The advantages claimed for these different methods of connection are that the current transmitted by the hearth of the furnace can be varied from zero to .707 of the sum of the currents by all the electrodes. When the current is zero the hearth can be made of non-conducting material." (Note: This is made use of in all "Greaves-Etchells" furnaces of four or more electrodes where current can be introduced either through top electrodes only, or by change of an oil switch through all top electrodes and through the furnace hearth—a balanced load being obtained with either method and also independent control of each electrode.) "A third patent, No. 1,302,788, differs from the previous ones in reversing the connection of both the high tension winding and the low tension secondary, making the primary a "star" or Y connection and the secondary a delta. The committee considered the method applied ingenious and successful. The rights and patents of the "Greaves-Etchells" system are controlled in America by the Electric Furnace Construction Company, Philadelphia, Pa.

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